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## TESTING INSTRUMENTS FOR ELECTRIC LIGHT COMPANIES.

IT may not be out of place at the present moment to give an idea of what class of apparatus would be found both convenient and necessary for accurately testing the various factors from which we obtain the results establishing the efficiency of dynamo-electric machines, arc and incandescent lamps, &c. We do not think that this matter has yet created the interest amongst electric light engineers which its importance demands, but which, in course of time, will be forced upon them. Just as the crude instruments formerly used in telegraphy have been displaced by the most delicate apparatus science can produce, so will it be essential that the laboratories in the factories of electric light companies shall be fitted up with something more than rough or approximate means of testing. At present we are not aware of any place in which this has been attempted, and we can only express a feeling of surprise at the primitive methods adopted by some of the most successful companies for obtaining data upon which to build future results. To Messrs. Ayrton and Perry all praise is due for their indefatigable efforts towards producing practical instruments which any one of ordinary intelligence can use and understand, and these endeavours have been highly successful as far as the purpose intended is concerned. But for laboratory work of an experimental kind we require apparatus more to be depended on than the ammeter, voltmeter, &c., which, at their best, can only be looked upon as approximately correct, and then but within a certain range. For measuring resistances, it is very desirable that two "Wheatstone bridges" be employed, as the range of measurements will be extensive. When measuring the lengths of wire composing the various sections on the bobbins or armatures of Gramme machines some years ago, we used a divided "metre" bridge, arranged in the following manner: In the testing-room, and forming the adjustable resistance, were various lengths of copper wire of the same section as that coiled on the bobbin of the machine, and dipping into mercury cups. These lengths of wire could be short-circuited by placing thick copper straps into the cups. The wire employed was of No. 12 B.W.G., and the number of lengths added up equalled the total length of each section on the bobbin (thirty feet).

The bobbin which formed the unknown side of the bridge was in the adjoining factory, to which leading wires were carried, but the resistance of these was eliminated by Sabine's method (see Tables and Formulæ), so that they were quite ignored. As each of the sections of wire for coiling on to the armature were always cut to thirty feet, they all had as nearly as possible the same resistance, being of such large sectional area. Therefore instead of measuring the actual resistance of each section when coiled on the armature, we obtained its actual length, which could easily be done, within less than 1 per cent., so that had a section become short-circuited it was an easy matter to tell the workman how many inches or feet he must uncoil to find the bad place. This arrangement from testing-room to factory, with the elimination of the leading wires, was found to be extremely effective, and the tests could be rapidly made. A mirror galvanometer of low resistance (half an ohm) will be found the most convenient for use with this system. For high resistances, such as the insulation between sections, we employed the "dial pattern" bridge manufactured by Elliott Bros., and a second mirror galvanometer of about 6,000 ohms resistance. A most useful adjunct to these for the purpose of measuring the resistances of incandescent lamps when hot would be the form of bridge arranged by Mr. Crookes for his tests in the Paris Exhibition, a description of which will be found in our other columns. The "metre" bridge, however, could be adapted to fulfil the same end. For testing the electromotive force of any machine we generally employed the condenser discharge, which will be found the most accurate, although of course involving a little more trouble than some other methods. Standard condensers are generally made sufficiently well to withstand any difference of potential to which they might be subjected by the dynamo-electric machines at present in use. With respect to the galvanometers we have already specified two forms, and a useful addition to these would be a resistance-box, containing resistances varying from 0·1 to 10,000 ohms for use as a shunt, a variable resistance being much more useful for this purpose than the fixed shunt of 1-9th, 1-99th, 1-999th, generally sold with the galvanometers. We have some time since, in our articles on "Electric Light Measurements," pointed out what we considered the best and simplest method of testing the strength of the current, viz., with a tangent galvanometer and resistance coils, and we do not think it necessary to add anything further on this matter.

Of course, with the apparatus we have mentioned, a considerable number of minor instruments will be required, such as galvanometer and battery reversing keys, discharge keys, short-circuiting keys, &c. These, together with the more handy and practical appliances of Ayrton and Perry for the approximate tests, would enable all the measurements necessary in electric lighting practice to be carried to a much higher standard of efficiency than has hitherto been the case.

It is a curious thing that directors of these companies do not hesitate to spend money freely in buying cables supposed to be good and thoroughly tested, but which have to be thrown on one side in a short time as useless, yet one but rarely comes across any company whose electricians are in a position to check the tests of manufacturers of electrical apparatus with whom they deal. A little cash judiciously expended in a good set of testing instruments might have saved many a breakdown in the past, and surely the companies' electricians themselves, if not absolutely new hands at electrical science, should insist upon securing proper appliances wherewith to go about their duties. It must be quite understood that we are speaking of a permanent installation of testing apparatus for determining accurately every factor entering into the efficiency of any particular mode of electric lighting, and not of a system which can be taken about from one place to another. For, in the practical work of fitting up electric machinery and lamps, there can be employed numerous galvanometers and other

instruments, and various simple but rough ways of measuring currents, which we have not here thought necessary to enter upon. But for any electric light company starting fairly well as regards the value of the system it possesses, it is absolutely essential that the same skilled testing and supervision of manufacture shall be exercised as is to be found in cable works or similar places, if the company desires to keep up to the progress of the times.

## INCANDESCENT ELECTRIC LAMPS IN THE PARIS EXHIBITION OF 1881.

IN our next columns will be found published at length the Report of the Sub-Commission appointed to investigate the efficiency of the incandescent lamps which formed so great an attraction in the late exhibition of Paris, and which really formed the starting-point in the installation of these lamps on a large scale.

It will be seen that the tests were numerous, and as far as they went, exhaustive; the measuring instruments and methods employed being more complete than is usual even in the more recent tests of incandescent lamps. The condenser method of obtaining the electromotive force is probably the only one in which strict accuracy can be obtained, as the original galvanometer deflection of the standard Daniell cell, generally employed for comparison, can always be reproduced for any other electromotive force by suitably shunting the galvanometer. The method of obtaining the resistance of the lamp when hot is to be commended, and we believe that this is the first time in which the Wheatstone Bridge has been so used.

The average resistance of the ten Edison lamps tested cold is 241 ohms, and when heated to give a light of sixteen candles, 136·9 ohms, a difference of about 56 per cent. When the current was increased sufficiently to raise their illuminating power to 32 candles, their average resistance had fallen to 130 ohms, or a difference in resistance of about 5 per cent., produced by the respective heats developed in the carbon filaments at 16 and 32 candle-power.

The difference in resistance between the measurements cold and at 16 candle-power of the Swan, Maxim, and Lane-Fox lamps respectively is 55·5, 57, and 50 per cent., and between this and 32 candle-power 3, 3·6, and 3 per cent.

The high resistance of the Edison filaments is very remarkable, considering that the other three are so nearly alike, and to this high resistance, and necessarily smaller section of carbon, is due the superiority of the Edison lamp as shown in Paris. We believe, however, that the resistance of the Edison lamps in London is considerably lower than here stated.

A set of similar tests on the lamps which have recently been in operation at the Crystal Palace Electrical Exhibition would have been invaluable, and probably might have shown improvements in the Lane-Fox and Swan lamps, which are certainly more advanced than those shown in Paris. In our issue of April 22nd we reprinted in full the interesting paper on "Tests of Incandescent Lamps," by Mr. A. Jamieson, which was read before the Society of Telegraph Engineers and of Electricians. Mr. Jamieson, however, had not so many lamps of the various systems at command, and his results, therefore, cannot compare in thoroughness with those of Mr. Crookes and his colleagues. The report is most valuable, and we must express our admiration at the completeness of the data given, and trust that Mr. Crookes will soon have an opportunity of doing in England what he did so well in Paris, but on a larger scale, if possible. To engineers experimenting on the efficiency of the electric light, whether arc or incandescent, we would by all means recommend the employment of the same class of instruments and method of measurement adopted as those used in Paris. For practical purposes, of course, the more simple apparatus lately devised answer well enough, but for strictly reliable data, it is absolutely necessary that strictly accurate instruments should be at hand, and to our mind the tests to which we have referred have been made more scientifically and satisfactorily than any preceding or after experiments within our knowledge.

## REPORT ON THE INCANDESCENT LAMPS EXHIBITED AT THE INTERNATIONAL EXPOSITION OF ELECTRICITY, PARIS, 1881.

THE following report by the Sub-Committee appointed to investigate the incandescent lamps shown in action during the late Electrical Exhibition in Paris will be found of considerable value to those of our readers engaged in electric lighting. Included amongst the names on this Commission were those of Professors W. Crookes and G. F. Barker, to the former of whom we are indebted for the copy of the results obtained.

### I. DESCRIPTION OF THE LAMPS.

The only lamps in the exhibition which were purely incandescent in character were those of Edison and Maxim, in the United States Section, and those of Swan and Lane-Fox, in that of Great Britain. The idea represented in these lamps is essentially the same in all of them, the differences being, for the most part, details of construction. They all consist of a glass envelope more or less spherical in form, in which is enclosed a carbon loop, made of carbonised organic material, and supported upon wires of platinum sealed into the glass. The space in the interior of the lamp is very perfectly exhausted.

#### A. THE EDISON LAMP.

The Edison lamp is pear-shaped in form. The carbon filament is long and fine, and is bent into the shape of a U. It is made from Japanese bamboo, cut to the requisite size in a gauge. In section it is nearly square, being about 0·3 millimetre on a side, the ends being left considerably wider. The fibre is carbonised in moulds of nickel, and is attached to the conducting wires by copper, electrolytically deposited upon them.

#### B. THE SWAN LAMP.

The Swan lamp is globular in form, the neck being quite long. The carbon filament is made from cotton-thread, parchmentised before carbonisation by treatment with strong sulphuric acid. The ends of this filament are very much thickened, and the loop has a double turn at the top. Its ends are clamped in a pair of metal holders, supported laterally by a stem of glass which rises through the neck to the base of the globe. Below, these holders are fastened to wires of platinum which pass through the glass.

#### C. THE MAXIM LAMP.

The Maxim lamp is also globular in form, but it has a short neck. Within the neck rises a hollow cylinder of glass, supporting upon its summit a column of blue enamel, through which pass the conducting wires of platinum which carry the carbon. The filament is made from cardboard cut by a punch into the form of an M. In section therefore it is rectangular, and several times as broad as it is thick. It is carbonised in a mould through which a current of coal-gas is passed. After carbonisation, the filament is placed in an attenuated atmosphere of hydrocarbon vapour and heated by the current. The vapour is decomposed, and its carbon is precipitated upon the filament. In this way not only are inequalities obliterated, but the resistance of the filaments may be equalised, and brought to any standard required.

#### D. THE LANE-FOX LAMP.

The Lane-Fox lamp is ovoid in shape, the neck being in length intermediate between the two lamps last described. The carbon is in the form of a horse-shoe, and is circular in cross-section. It is made from the root of an Italian grass, largely used in France for making brooms. After carbonisation, the filaments are classified according to their resistances. They are then heated in an atmosphere of coal-gas, by which carbon is deposited upon them, as in the filaments of the lamps last described. The filament in the lamp is supported by platinum wires, to which it is attached by sleeves of carbon encircling both. These wires pass through tubes in the top of a hollow glass stem. Just below the extremities of these tubes are two small bulbs containing

mercury, forming the contact between the platinum wire sealed into the glass above and the copper conductor which enters from below. These conductors are held in place by plaster which fills the base of the lamp.

## II. METHODS OF MEASUREMENT.

The question to be determined was simply the efficiency of these lamps. The efficiency of a lamp is the ratio of energy produced to energy consumed, *i.e.*, the quantity of light given by the lamp for each horse-power of current which it consumes. The data required to calculate this efficiency may be obtained when the electromotive force of the current, the resistance of the lamp when giving its light, and its illuminating power have been determined.

### 1. *Electromotive Force.*

The electromotive force, or fall of potential through the lamp, was measured by Laws's method (see fig. 1). A suitable condenser was charged by being put in communication

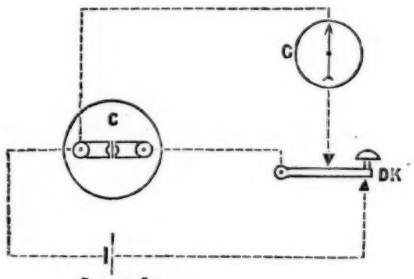

FIG. 1

with a standard Daniell cell, and then discharged through a high resistance galvanometer, the deflection of the needle being noted. This condenser was then connected to the two wires of the lamp, and again discharged through the galvanometer, the deflection being made the same as before by means of a variable shunt connected with the galvanometer (see fig. 2). Since with a given condenser the charges it

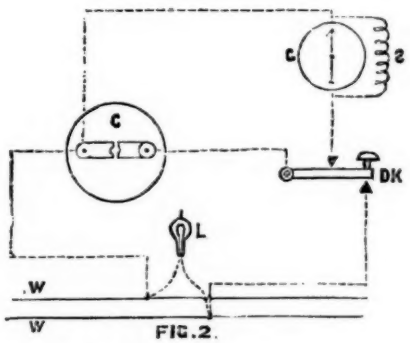

FIG. 2.

receives are proportional to the potentials of the charging currents, and since the discharge deflections of a galvanometer represent the quantity of these charges, it follows that the electromotive forces are proportional to these discharge deflections. If however, as in the present case, the discharge deflections are made equal by means of shunts, then the electromotive forces are proportional to the multiplying power of the shunts.

### 2. *Resistance.*

The resistance of the lamp, when giving its light, was obtained by making the lamp one side of a Wheatstone's bridge through which the main current was flowing. The second and fourth sides were formed of fixed resistances of known value, and the third side of an adjustable resistance (see fig. 3). When the bridge is balanced, the product of the two fixed resistances, divided by the adjusted resistance, gives the resistance of the lamp at the given candle-power.

### 3. *Illuminating Power.*

The illuminating power of the lamp was measured on a Bunsen photometer. At one end of the bar was the lamp itself; at the other end two standard candles, placed nearly

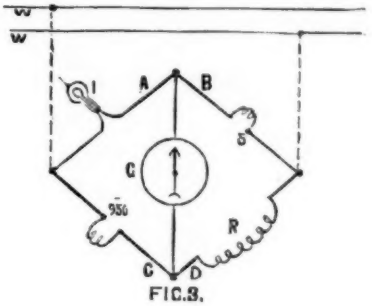

FIG. 3.

in line. The plane of the carbon filament was placed at 45° to the length of the bar, and each lamp was measured at 16 and 32 candles.

## III. APPARATUS EMPLOYED.

### 1. *Condenser.*

The condenser used in these measurements had a capacity of 1 microfarad, divided into sections of 0·4, 0·3, 0·2, and 0·1. The dielectric was paraffined mica, and the brasswork was supported on ebonite pillars. Made by Latimer Clark, Muirhead, and Co., London, and exhibited in their Section at the Exhibition.

### 2. *Galvanometer.*

The galvanometer was a Thomson double-coil astatic instrument, inclosed in a square case with glass sides. Measured resistance, 6550 ohms. Used with lampstand and scale, in the ordinary way. Made by Elliott Brothers, London.

### 3. *Standard Cell.*

An ordinary Daniell cell, the copper plate being immersed in a saturated solution of pure copper sulphate, contained in the porous cell, and the zinc plate amalgamated, in a saturated solution of pure zinc sulphate, in the outer jar; one of a battery of ten cells forming a part of the Edison exhibit.

### 4. *Resistance Coils.*

(*a.*) A set of standard coils, measuring from 1 ohm to 5,000 ohms. All other resistances employed were standardised by these. Made by L. Clark, Muirhead, and Co., and a part of their exhibit. (*b.*) A set of coils used in the Wheatstone's bridge. Compared carefully with set (*a.*). These coils formed a part of the exhibit of Edison.

### 5. *Wheatstone's Bridge.*

Four conducting wires of large size arranged on the table in the form of a rhomb. A test galvanometer was inserted between the obtuse angles of the rhomb, and a pair of shunt wires from the main conductors were attached at the acute angles. The first side of the rhomb contained the lamp to be measured, standing in its place on the photometer. The second side contained a fixed resistance of 5 ohms. The third side contained a variable resistance (Resistance *b*); and the fourth side a fixed resistance of 950 ohms. This bridge formed a part of the Edison exhibit.

### 6. *Photometer.*

The photometer employed was of the Bunsen form, having a double bar, 80 inches long, graduated in inches and in candles. The disc was of paraffined paper, with a plain spot in the centre. The disc box was movable on rollers, and contained inclined mirrors to facilitate the adjustment. The candles used were of spermaceti, made by Sugg, of London, to burn 120 grains (7·776 grms.) per hour. The entire apparatus was surrounded with heavy black cloth. Also a part of the Edison exhibit.

### 7. *Dynamo-electric Machine.*

An Edison sixty-light machine was used to furnish the current required. In this machine the field-magnets, which are very long and heavy, stand vertically. The field is maintained by a shunt current, regulated by an adjustable resistance in its circuit. The bobbin is wound on a cylinder like that of Siemens, from which it differs, however, in its details. Its resistance was only 0·03 ohm, and the current delivered, at a speed of 900 revoluions, had an electromotive force of 110 volts. A part of the Edison exhibit.

## IV. RESISTANCE OF LAMPS COLD.

The resistance of the lamps cold was measured on a Wheatstone's bridge of the ordinary form and in the usual way. The Edison lamps were taken at random from the stock on hand. The Swan lamps were furnished by Mr. Edmunds, the Lane-Fox lamps by Mr. Stewart, and the Maxim lamps by Mr. Lockwood. Twenty-four of each were taken (except the Lane-Fox, of which only fifteen were furnished), and ten selected from these for the tests. The measurements of the Edison and Swan lamps were made by Mr. E. G. Acheson; those of the Lane-Fox and Maxim lamps by Mr. H. Crookes. The following are the results obtained:—

| Number. | Edison. | Swan. | Lane-Fox. | Maxim. |
|---|---|---|---|---|
| 1. | 237 | 74 | 53 | 73 |
| 2. | 233 | 50 | 56 | 84 |
| 3. | 268 | 54 | 56 | 76 |
| 4. | 260 | 73 | 56 | 74 |
| 5. | 251 | 55 | 54 | 74 |
| 6. | 228 | 72 | 50 | 71 |
| 7. | 227 | 39 | 53 | 68 |
| 8. | 249 | 67 | 52 | 63 |
| 9. | 219 | 55 | 57 | 65 |
| 10. | 237 | 52 | 63 | 73 |
| Mean | 241 | 59 | 55 | 72 |

## V. MEASUREMENT OF EFFICIENCY.

### 1. *Experimental Results.*

### A. THE EDISON LAMP.

In this measurement the entire condenser was employed. When charged with the standard cell and discharged through the galvanometer without shunt, a deflection of 310 scale divisions was obtained, as a mean of ten closely accordant experiments. The photometer readings were made by Mr, Crookes, the bridge readings by Major R. Y. Armstrong. and the galvanometer readings by Prof. G. F. Barker.

*(a.) At* 16 *Candles.*

| Number of Lamp. | Photometer Reading. | Bridge Reading. | Galvanometer Reading. |
|---|---|---|---|
| 1. | 16—14·75 | 35—34·5 | 75 |
| 2. | 16—15 | 35·0 | 74 |
| 3. | 16 | 30·5 | 74 |
| 4. | 16 | 32·3 | 73 |
| 5. | 16—17 | 33·4 | 73 |
| 6. | 16—17·5 | 36·0 | 73 |
| 7. | 16—15 | 36·6 | 78 |
| 8. | 16 | 34·5 | 75 |
| 9. | 16—19 | 37·5 | 74 |
| 10. | 16 | 37·7 | 74 |

*(b.) At* 32 *Candles.*

| Number. | Photometer. | Bridge. | Galvanometer. |
|---|---|---|---|
| 1. | 32 | 37·2 | 66 |
| 2. | 32 | 37·2 | 65 |
| 3. | 32 | 32·2 | 66 |
| 4. | 32 | 34·3 | 64 |
| 5. | 32 | 35·2 | 67 |
| 6. | 32 | 37·9 | 69 |
| 7. | 32 | 38·5 | 69 |
| 8. | 32 | 36·3 | 69 |
| 9. | 32 | 38·9 | 69 |
| 10. | 32 | 38·8 | 69 |

### B. THE SWAN LAMP.

The entire condenser was used in these measurements also, the deflection being 310 divisions. The photometer was read by Mr. H. Crookes, the bridge by Mr. Crookes, and the Galvanometer by Prof. Barker.

*(a.) At* 16 *Candles.*

| Number. | Photometer. | Bridge. | Galvanometer. |
|---|---|---|---|
| 1. | 16 | 119·5 | 136 |
| 2. | 16 | 161·7 | 145 |
| 3. | 16 | 148·8 | 137 |
| 4. | 16 | 113·5 | 122 |
| 5. | 16 | 145·9 | 134 |
| 6. | 16 | 122·1 | 138 |
| 7. | 16 | 229·0 | 179 |
| 8. | 16 | 135·1 | 145 |
| 9. | 16 | 159·5 | 146 |
| 10. | 16 | 171·0 | 145 |

*(b.) At* 32 *Candles.*

| Number. | Photometer. | Bridge. | Galvanometer. |
|---|---|---|---|
| 1. | 32 | 123·5 | 121 |
| 2. | 32 | 167·2 | 122 |
| 3. | 32 | 155·2 | 121 |
| 4. | 32 | 116·0 | 116 |
| 5. | 32 | 154·7 | 115 |
| 6. | 32 | 129·7 | 120 |
| 7. | 32 | 237·0 | 146 |
| 8. | 32 | 137·5 | 128 |
| 9. | 32 | 163·0 | 127 |
| 10. | 32 | 175·2 | 120 |

### C. THE LANE-FOX LAMP.

The entire condenser was employed, and the deflection was the same, 310 divisions. Mr. H. Crookes read the photometer, Mr. Crookes the bridge, and Prof. Barker the galvanometer.

*(a.) At* 16 *Candles.*

| Number. | Photometer. | Bridge. | Galvanometer. |
|---|---|---|---|
| 1. | 16 | 172·0 | 150 |
| 2. | 16 | 168·7 | 145 |
| 3. | 16 | 177·6 | 161 |
| 4. | 16 | 171·7 | 157 |
| 5. | 16 | 171·0 | 156 |
| 6. | 16 | 189·5 | 156 |
| 7. | 16 | 179·0 | 156 |
| 8. | 16 | 181·1 | 164 |
| 9. | 16 | 161·7 | 146 |
| 10. | 16 | 164·7 | 148 |

*(b.) At* 32 *Candles.*

| Number. | Photometer. | Bridge. | Galvanometer. |
|---|---|---|---|
| 1. | 32 | 178·7 | 135 |
| 2. | 32 | 175·5 | 129 |
| 3. | 32 | 181·2 | 149 |
| 4. | 32 | 175·2 | 148 |
| 5. | 32 | 175·7 | 143 |
| 6. | 32 | 192·3 | 143 |
| 7. | 32 | 186·2 | 146 |
| 8. | 32 | 184·5 | 146 |
| 9. | 32 | 167·3 | 133 |
| 10. | 32 | 172·0 | 129 |

### D. THE MAXIM LAMP.

The entire condenser was used, as in the previous cases. But the deflection obtained was 315 divisions, owing probably to the higher temperature of the room. Photometer read by Mr. H. Crookes, bridge by Mr. Crookes, galvanometer by Prof. G. F. Barker.

*(a.) At* 16 *Candles.*

| Number. | Photometer. | Bridge. | Galvanome |
|---|---|---|---|
| 1. | 16 | 111·8 | 115 |
| 2. | 16 | 111·3 | 119 |
| 3. | 16 | 106·2 | 111 |
| 4. | 16 | 124·7 | 120 |
| 5. | 16 | 111·9 | 122 |
| 6. | 16 | 138·5 | 121 |
| 7. | 16 | 122·0 | 122 |
| 8. | 16 | 115·6 | 118 |
| 9. | 16 | 120·6 | 123. |
| 10. | 16 | 103·0 | 111 |

*(b.) At* 32 *Candles.*

| Number. | Photometer. | Bridge. | Galvanometer. |
|---|---|---|---|
| 1. | 32 | 114·6 | 102 |
| 2. | 32 | 114·8 | 106 |
| 3. | 32 | 109·7 | 100 |
| 4. | 32 | 128·6 | 112 |
| 5. | 32 | 114·5 | 112 |
| 6. | 32 | 140·8 | 113 |
| 7. | 32 | 126·9 | 110 |
| 8. | 32 | 120·4 | 105 |
| 9. | 32 | 126·5 | 110 |
| 10 | 32 | 109·7 | 101 |

### E. THE CANDLE RECORD.

#### 1. *Edison Lamp.*

| Candle-power. | Loss in Grms. | Time in Mins. | Loss per Minute. |
|---|---|---|---|
| 16 | 18·13 | 73 | 0·2483 |
| 32 | 21·22 | 84 | 0·2526 |

#### 2. *Swan Lamp.*

| | | | |
|---|---|---|---|
| 16 and 32 | 34·15 | 126 | 0·2695 |

#### 3. *Lane-Fox Lamp.*

| | | | |
|---|---|---|---|
| 16 and 32 | 40·70 | 153·75 | 0·2647 |

#### 4. *Maxim Lamp.*

| | | | |
|---|---|---|---|
| 16 and 32 | 26·90 | 104 | 0·2586 |

### 2. *Methods of Calculation.*

1. *Illuminating Power.*—The standard candle should burn 7·776 grms. spermaceti per hour, or 0·1296 grm. per minute. The two candles used should burn 0·2592 grm. per minute. The corrected candle-power of the lamp, therefore, is obtained by the proportion: As 0·2592 is to the amount actually burned per minute, so is the observed candle-power to the corrected candle-power.

2. *Resistance (hot).*—From the theory of the Wheatstone bridge, the resistance of either side is equal to the product of the adjacent sides divided by the opposite side. In the bridge used for the measurement, the resistances in the two adjacent sides were 950 and 5 ohms. Hence, by dividing their product, 4750, by the reading of the variable resistance observed, the resistance of the lamp hot is obtained.

3. *Electromotive Force.*—In Laws's method the electromotive forces are proportional to the multiplying power of the shunts employed. Since with the Daniell cell no shunt was used, the multiplying power of the shunt used with the lamp-current represented directly the electromotive force through the lamp, in terms of the standard cell. The multiplying power of a shunt is the sum of the galvanometer resistance and the shunt resistance divided by the shunt resistance. In this case the resistance of the galvanometer was 6550 ohms. Hence, if s represent the resistance of the shunt, obtained by experiment,

$$\frac{6550+s}{s}$$

will represent the electromotive force. Since the electromotive force of a Daniell cell is not 1 volt, as here assumed, but 1·079 volts, strict accuracy would require the figures given to be increased in that ratio. Moreover, the small error arising from the inductive action of the needle on the galvanometer coils has been regarded as unimportant.

4. *Current.*—By the law of Ohm the current strength is the quotient of electromotive force by resistance. Dividing the electromotive force in volts by the resistance in ohms the current strength is obtained in ampères.

5. *Electrical Energy.*—The work done by a current is proportional to the product of the square of the current strength into the resistance of the circuit. Or, since the electromotive force is equal to the product of the current strength by the resistance, the energy is represented by the product of the electromotive force in volts by the current strength in ampères. This gives the energy in volt-ampères.

6. *Mechanical Energy.*—Since an absolute unit of work is done per second by an absolute unit of electromotive force in a circuit of one absolute unit of resistance, 1 volt-ampère represents $10^7$ absolute units of mechanical work per second, or 0·10192 kilogrm.-metres. By multiplying the volt-ampères by 0·10192, the product is the mechanical work done in the lamp in kilogrm.-metres.

7. *Lamps per Horse-power of Current.*—One horse-power is 75 kilogrm.-metres per second. By dividing 75, therefore, by the number of kilogrm.-metres of work done in the lamp per second, the quotient is the number of such lamps maintained by a horse-power of current.

8. *Candles per Horse-power of Current.*—The number of candle-lights per horse-power of current is obtained, of course, by multiplying the number of lamps per horse-power of current by the corrected candle-power of each.

9. *Normal Lamps per Horse-power of Current.*—Conversely, by dividing the number of candles per horse-power of current by the normal value of the lamp in standard candles (in the present case 16 or 32), the number of normal lamps per horse-power of current is obtained.

### 3. *Calculated Results.*

#### A. THE EDISON LAMP.

##### (*a.*) *At* 16 *Candles.*

| Number. | Candles. (corrected.) | Ohms. | Volts. | Ampères. |
|---|---|---|---|---|
| 1. | 14·73 | 136·7 | 88·33 | 0·646 |
| 2. | 14·85 | 135·7 | 89·51 | 0·660 |
| 3. | 15·33 | 155·7 | 89·51 | 0·575 |
| 4. | 15·33 | 147·3 | 90·73 | 0·616 |
| 5. | 15·81 | 142·2 | 90·73 | 0·638 |
| 6. | 16·04 | 132·0 | 90·73 | 0·687 |
| 7. | 14·85 | 129·8 | 84·97 | 0·655 |
| 8. | 15·33 | 137·7 | 88·33 | 0·641 |
| 9. | 16·76 | 126·6 | 89·51 | 0·707 |
| 10. | 15·33 | 126·0 | 89·51 | 0·710 |

| Number. | Volt-Ampères. | Kilogram-metres. | Lamps per Horse-power. | Candles per Horse-power. |
|---|---|---|---|---|
| 1. | 57·08 | 5·819 | 12·88 | 189·8 |
| 2. | 59·05 | 6·020 | 12·46 | 185·0 |
| 3. | 51·46 | 5·246 | 14·29 | 219·1 |
| 4. | 55·88 | 5·697 | 13·16 | 201·8 |
| 5. | 57·88 | 5·901 | 12·71 | 200·8 |
| 6. | 62·36 | 6·357 | 11·80 | 189·3 |
| 7. | 55·63 | 5·671 | 13·22 | 205·0 |
| 8. | 56·67 | 5·777 | 12·98 | 199·0 |
| 9. | 63·29 | 6·453 | 11·62 | 194·9 |
| 10. | 63·45 | 64·69 | 11·60 | 177·7 |

#### A. THE EDISON LAMP.

##### (*b.*) *At* 32 *Candles.*

| Number. | Candles. (corrected.) | Ohms. | Volts. | Ampères. |
|---|---|---|---|---|
| 1. | 31·11 | 127·7 | 100·20 | 0·785 |
| 2. | 31·11 | 127·7 | 101·80 | 0·797 |
| 3. | 31·11 | 147·5 | 100·20 | 0·679 |
| 4. | 31·11 | 138·5 | 103·30 | 0·746 |
| 5. | 31·11 | 134·9 | 98·76 | 0·732 |
| 6. | 31·11 | 125·3 | 95·93 | 0·765 |
| 7. | 31·11 | 123·4 | 95·93 | 0·778 |
| 8. | 31·11 | 130·8 | 95·93 | 0·733 |
| 9. | 31·11 | 122·1 | 95·93 | 0·786 |
| 10. | 31·11 | 122·4 | 95·93 | 0·784 |

| Number. | Volt-Ampères. | Kilogram-metres. | Lamps per Horse-power. | Candles per Horse-power |
|---|---|---|---|---|
| 1. | 78·70 | 8·023 | 9·35 | 291·0 |
| 2. | 81·11 | 8·269 | 9·07 | 282·2 |
| 3. | 68·12 | 6·945 | 10·80 | 333·7 |
| 4. | 77·12 | 7·862 | 9·54 | 296·8 |
| 5. | 72·28 | 7·369 | 10·18 | 316·6 |
| 6. | 73·42 | 7·486 | 10·02 | 311·7 |
| 7. | 74·59 | 7·604 | 9·86 | 306·9 |
| 8. | 70·32 | 7·169 | 10·46 | 325·4 |
| 9. | 75·36 | 7·683 | 9·76 | 303·7 |
| 10. | 75·17 | 7·633 | 9·79 | 304·5 |

#### B. THE SWAN LAMP.

##### (*a.*) *At* 16 *Candles.*

| Number. | Candles. (corrected.) | Ohms. | Volts. | Ampères. |
|---|---|---|---|---|
| 1. | 16·61 | 39·75 | 49·16 | 1·237 |
| 2. | 16·61 | 29·38 | 46·17 | 1·536 |
| 3. | 16·61 | 31·92 | 48·81 | 1·529 |
| 4. | 16·61 | 41·85 | 54·69 | 1·307 |
| 5. | 16·61 | 32·56 | 49·88 | 1·532 |
| 6. | 16·61 | 38·90 | 48·47 | 1·246 |
| 7. | 16·61 | 20·74 | 37·59 | 1·812 |
| 8. | 16·61 | 35·16 | 46·17 | 1·313 |
| 9. | 16·61 | 29·78 | 45·86 | 1·540 |
| 10. | 16·61 | 27·78 | 46·17 | 1·662 |

| Number. | Volt-Ampères. | Kilogram-metres. | Lamps per Horse-power. | Candles per Horse-power. |
|---|---|---|---|---|
| 1. | 60·80 | 6·199 | 12·10 | 200·9 |
| 2. | 72·57 | 7·399 | 10·14 | 168·3 |
| 3. | 74·63 | 7·609 | 9·86 | 163·7 |
| 4. | 71·47 | 7·286 | 10·29 | 170·9 |
| 5. | 76·42 | 7·791 | 9·63 | 159·8 |
| 6. | 60·38 | 6·155 | 12·18 | 202·3 |
| 7. | 68·13 | 6·946 | 10·80 | 179·3 |
| 8. | 60·64 | 6·182 | 12·13 | 201·5 |
| 9. | 70·62 | 7·201 | 10·41 | 173·0 |
| 10. | 76·75 | 7·824 | 9·59 | 159·5 |

### B. THE SWAN LAMP.

*(b.) At 32 Candles.*

| Number. | Candles. | Ohms. | Volts. | Ampères. |
|---|---|---|---|---|
| 1. | 33·21 | 39·36 | 55·13 | 1·401 |
| 2. | 33·21 | 28·41 | 54·69 | 1·925 |
| 3. | 33·21 | 30·61 | 55·13 | 1·801 |
| 4. | 33·21 | 40·95 | 57·47 | 1·403 |
| 5. | 33·21 | 30·71 | 57·96 | 1·888 |
| 6. | 33·21 | 36·62 | 55·58 | 1·514 |
| 7. | 33·21 | 20·09 | 45·86 | 2·288 |
| 8. | 33·21 | 34·54 | 52·17 | 1·510 |
| 9. | 33·21 | 29·14 | 52·57 | 1·804 |
| 10. | 33·21 | 27·11 | 55·58 | 2·050 |

| Number. | Volt-Ampères. | Kilogram-metres. | Lamps per Horse-power. | Candles per Horse-power. |
|---|---|---|---|---|
| 1. | 77·23 | 7·87 | 9·526 | 316·4 |
| 2. | 105·30 | 10·73 | 6·988 | 232·1 |
| 3. | 99·31 | 10·12 | 7·407 | 246·0 |
| 4. | 80·64 | 8·22 | 9·122 | 302·9 |
| 5. | 109·40 | 11·15 | 6·725 | 223·3 |
| 6. | 84·36 | 8·60 | 8·720 | 289·6 |
| 7. | 104·90 | 10·70 | 7·010 | 232·5 |
| 8. | 78·79 | 8·03 | 9·337 | 310·1 |
| 9. | 94·85 | 9·67 | 7·756 | 257·6 |
| 10. | 114·00 | 11·62 | 6·456 | 214·4 |

### C. THE LANE-FOX LAMP.

*(a.) At 16 Candles.*

| Number. | Candles. (corrected.) | Ohms. | Volts. | Ampères. |
|---|---|---|---|---|
| 1. | 16·36 | 27·62 | 44·65 | 1·617 |
| 2. | 16·36 | 28·16 | 46·17 | 1·640 |
| 3. | 16·36 | 26·75 | 41·68 | 1·559 |
| 4. | 16·36 | 27·66 | 42·72 | 1·544 |
| 5. | 16·36 | 27·78 | 42·99 | 1·548 |
| 6. | 16·36 | 25·07 | 42·99 | 1·715 |
| 7. | 16·36 | 26·54 | 42·99 | 1·620 |
| 8. | 16·36 | 26·23 | 40·94 | 1·561 |
| 9. | 16·36 | 29·37 | 45·86 | 1·561 |
| 10. | 16·36 | 28·85 | 45·26 | 1·569 |

| Number. | Volt-Ampères. | Kilogram-metres. | Lamps per Horse-power. | Candles per Horse-power. |
|---|---|---|---|---|
| 1. | 72·25 | 7·365 | 10·18 | 166·6 |
| 2. | 75·72 | 7·719 | 9·72 | 158·9 |
| 3. | 64·96 | 6·623 | 11·33 | 185·2 |
| 4. | 65·97 | 6·726 | 11·15 | 182·4 |
| 5. | 66·52 | 6·782 | 11·06 | 160·9 |
| 6. | 73·72 | 7·516 | 9·98 | 163·2 |
| 7. | 69·64 | 7·100 | 10·56 | 172·8 |
| 8. | 63·90 | 6·515 | 11·51 | 188·3 |
| 9. | 71·60 | 7·300 | 10·27 | 168·1 |
| 10. | 71·02 | 7·240 | 10·36 | 169·4 |

### C. THE LANE-FOX LAMP.

*(b.) At 32 Candles.*

| Number. | Candles. (corrected.) | Ohms. | Volts. | Ampères. |
|---|---|---|---|---|
| 1. | 32·71 | 26·58 | 49·52 | 1·863 |
| 2. | 32·71 | 27·07 | 51·78 | 1·913 |
| 3. | 32·71 | 26·09 | 44·96 | 1·723 |
| 4. | 32·71 | 27·11 | 45·26 | 1·669 |
| 5. | 32·71 | 27·04 | 46·80 | 1·731 |
| 6. | 32·71 | 24·70 | 46·80 | 1·895 |
| 7. | 32·71 | 25·51 | 49·16 | 1·927 |
| 8. | 32·71 | 25·75 | 45·86 | 1·781 |
| 9. | 32·71 | 28·39 | 50·25 | 1·773 |
| 10. | 32·71 | 27·62 | 51·78 | 1·875 |

| Number. | Volt-Ampères. | Kilogram-metres. | Lamps per Horse-power. | Candles per Horse-power. |
|---|---|---|---|---|
| 1. | 92·25 | 9·495 | 7·98 | 260·9 |
| 2. | 99·04 | 10·100 | 7·43 | 243·0 |
| 3. | 77·47 | 7·898 | 9·50 | 310·7 |
| 4. | 75·56 | 7·702 | 9·74 | 318·6 |
| 5. | 81·03 | 8·261 | 9·08 | 297·1 |
| 6. | 88·69 | 9·042 | 8·30 | 271·4 |
| 7. | 94·74 | 9·659 | 7·77 | 254·0 |
| 8. | 81·70 | 8·330 | 9·00 | 294·6 |
| 9. | 88·93 | 9·066 | 8·27 | 270·7 |
| 10. | 97·07 | 9·896 | 7·58 | 247·9 |

### D. THE MAXIM LAMP.

*(a.) At 16 Candles.*

| Number. | Candles. (corrected.) | Ohms. | Volts. | Ampères. |
|---|---|---|---|---|
| 1. | 15·96 | 42·49 | 57·96 | 1·364 |
| 2. | 15·96 | 42·68 | 56·04 | 1·313 |
| 3. | 15·96 | 44·73 | 60·01 | 1·342 |
| 4. | 15·96 | 38·09 | 55·58 | 1·459 |
| 5. | 15·96 | 42·45 | 54·69 | 1·288 |
| 6. | 15·96 | 35·10 | 55·13 | 1·571 |
| 7. | 15·96 | 38·94 | 54·69 | 1·405 |
| 8. | 15·96 | 41·09 | 56·51 | 1·375 |
| 9. | 15·96 | 39·39 | 54·25 | 1·377 |
| 10. | 15·96 | 46·12 | 60·01 | 1·301 |

| Number. | Volt-Ampères. | Kilogram-metres. | Lamps per Horse-power. | Candles per Horse-power. |
|---|---|---|---|---|
| 1. | 79·06 | 8·060 | 9·335 | 148·5 |
| 2. | 73·59 | 7·503 | 9·996 | 159·6 |
| 3. | 80·51 | 8·208 | 9·137 | 145·9 |
| 4. | 81·11 | 8·269 | 9·070 | 144·8 |
| 5. | 70·46 | 7·183 | 10·440 | 166·7 |
| 6. | 86·61 | 8·830 | 8·494 | 135·6 |
| 7. | 78·62 | 7·832 | 9·577 | 152·9 |
| 8. | 77·71 | 7·923 | 9·466 | 151·1 |
| 9. | 74·73 | 7·619 | 9·844 | 157·2 |
| 10. | 78·09 | 7·961 | 9·421 | 150·4 |

### D. THE MAXIM LAMP.

*(b.) At 32 Candles.*

| Number. | Candles. | Ohms. | Volts. | Ampères. |
|---|---|---|---|---|
| 1. | 31·93 | 41·45 | 65·22 | 1·573 |
| 2. | 31·93 | 41·34 | 62·79 | 1·519 |
| 3. | 31·93 | 43·30 | 66·50 | 1·536 |
| 4. | 31·93 | 36·94 | 59·48 | 1·610 |
| 5. | 31·93 | 41·49 | 59·48 | 1·434 |
| 6. | 31·93 | 33·74 | 58·96 | 1·748 |
| 7. | 31·93 | 37·43 | 60·54 | 1·617 |
| 8. | 31·93 | 39·45 | 63·38 | 1·607 |
| 9. | 31·93 | 37·55 | 60·54 | 1·612 |
| 10. | 31·93 | 43·30 | 65·85 | 1·521 |

| Number. | Volt-Ampères. | Kilogram-metres. | Lamps per Horse-power. | Candles per Horse-power. |
|---|---|---|---|---|
| 1. | 105·00 | 10·710 | 7·006 | 223·7 |
| 2. | 95·38 | 9·724 | 7·713 | 246·3 |
| 3. | 102·10 | 10·410 | 7·203 | 230·0 |
| 4. | 95·79 | 9·766 | 7·680 | 245·2 |
| 5. | 85·29 | 8·695 | 8·625 | 275·4 |
| 6. | 103·00 | 10·510 | 7·138 | 227·9 |
| 7. | 97·93 | 9·984 | 7·512 | 239·8 |
| 8. | 101·80 | 10·380 | 7·225 | 230·7 |
| 9. | 97·62 | 9·954 | 7·536 | 240·6 |
| 10. | 100·00 | 10·210 | 7·346 | 234·5 |

### 4. *Summary of Results.*

*(a.) At 16 Candles.*

| | Edison. | Swan. | Lane-Fox. | Maxim. |
|---|---|---|---|---|
| Candles ... ... ... ... | 15·38 | 16·61 | 16·36 | 15·96 |
| Ohms ... ... ... ... | 137·4 | 32·78 | 27·40 | 41·11 |
| Volts ... ... ... ... | 89·11 | 47·30 | 43·63 | 56·49 |
| Ampères ... ... ... ... | 0·651 | 1·471 | 1·593 | 1·380 |
| Volt-Ampères ... ... | 57·98 | 69·24 | 69·53 | 78·05 |
| Kilogram-metres ... ... | 5·911 | 7·059 | 7·089 | 7·939 |
| Lamps per horse-power | 12·73 | 10·71 | 10·61 | 9·48 |
| Candles per horse-power | 196·4 | 177·92 | 173·58 | 151·27 |
| Lamps of 16 candles per horse-power ... ... | 12·28 | 11·12 | 10·85 | 9·45 |

### 4. *Summary of Results.*

*(b.) At 32 Candles.*

| | Edison. | Swan. | Lane-Fox. | Maxim. |
|---|---|---|---|---|
| Candles ... ... ... ... | 31·11 | 33·21 | 32·71 | 31·93 |
| Ohms ... ... ... ... | 130·03 | 31·75 | 26·59 | 39·60 |
| Volts ... ... ... ... | 98·39 | 54·21 | 48·22 | 62·27 |
| Ampères ... ... ... ... | 0·7585 | 1·758 | 1·815 | 1·578 |
| Volt-Ampères ... ... | 74·62 | 94·88 | 87·65 | 98·41 |
| Kilogram-metres ... ... | 7·604 | 9·67 | 8·936 | 10·03 |
| Lamps per horse-power | 9·88 | 7·90 | 8·47 | 7·50 |
| Candles per horse-power | 307·25 | 262·49 | 276·89 | 239·41 |
| Lamps of 32 candles per horse-power ... ... | 9·60 | 8·20 | 8·65 | 7·48 |

## VI. CONCLUSIONS.

The following conclusions seem to be sustained by the results which have now been given :—

1st.—The maximum efficiency of incandescent lamps in the present state of the subject, and within the experimental limits of this investigation, cannot be assumed to exceed 300 candle-lights per horse-power of current.

2nd.—The economy of all lamps of this kind is greater at high than at low incandescence.

3rd.—The economy of light-production is greater in high resistance lamps than in those of low resistance, thus agreeing with the economy of distribution.

4th.—The relative efficiency of the four lamps examined, expressed in Carcel burners of 7·4 spermaceti candles each, produced by one horse-power of current, is as follows :—(A.) At 16 candles : Edison, 26·5 ; Swan, 24 ; Lane-Fox, 23·5 ; and Maxim, 20·4. (B.) At 32 candles : Edison, 41·5 ; Lane-Fox, 37·4 ; Swan, 35·5 ; and Maxim, 32·4. To double the light given by these lamps the current-energy was increased, for the Maxim and Lane-Fox lamps, 26 per cent. ; for the Edison lamp, 28 per cent. ; and for the Swan lamp, 37 per cent.

In the figures which we have ourselves inserted to illustrate diagrammatically the methods of measurement adopted by Mr. Crookes, G represents the galvanometer, C the condenser, D K the discharge key, S the shunt, L the lamp, and W W the conducting wires (figs. 1 and 2). In fig. 3, A, B, C, D, represent the four sides of the "Wheatstone bridge." In the side, A, is placed the lamp, and a permanent resistance of 5 ohms is inserted in the side, B. The remaining sides are respectively made up of the adjustable resistance, R, and the fixed resistance of 950 ohms, as explained under "Apparatus employed" (5).

## THE LAMPE-SOLEIL.

THE construction of this lamp, which has recently been subjected to some improvements, is as follows :—

Two carbons, inclined at an angle of 40° slide, impelled by their own weight, in a rectangular block formed by the combination of refractory materials. The arc playing between the extremities of the carbons, heats internally the vertex of an angular piece of marble placed on the bottom or side of the block, and the luminous rays are projected in a very open conical sheaf, either downwards, as shown in fig. 1, or sideways, when the open part of the piece of marble is placed on the side of the block.

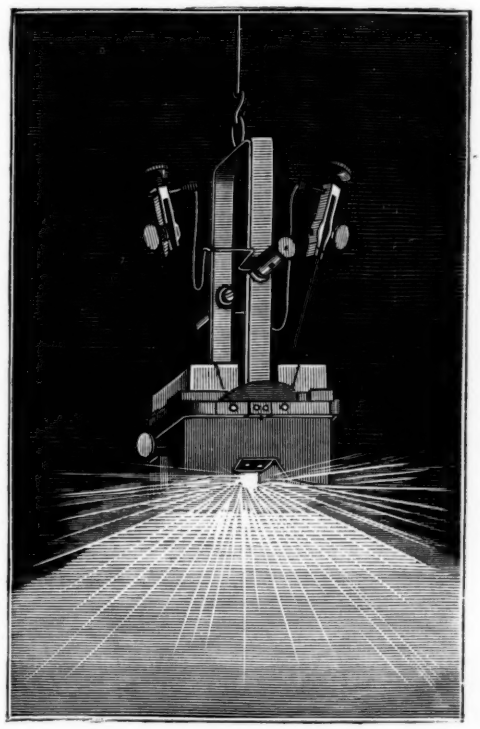

FIG. 1.

For lighting, the extremities of the carbons are connected by a wick impregnated with a paste of carbon. This conducting wick allows, first, of the passage of the current, then it is destroyed and the arc is formed. The light is produced as much by the arc itself as by the incandescence of the marble, which is transformed into lime by the heat of the arc.

It must be observed that in this arrangement the refractory substance destined to become incandescent is placed between the carbons within the acute angle which they form. In the course of the experiments made by the inventors, this substance was first placed outside the angle. With this arrangement, the arc, which tends to form a curve, that is, convex in relation to the extremities of the carbons, was distorted by the refractory block, the surface of which it licked, but owing to its tendency to resume its original form, it soon made a hollow in the block, into which it disappeared, and the lamp no longer gave any light.

With the arrangement adopted the arc follows the refractory substance, all the while preserving its concave form, and thus its disappearance is no longer to be feared.

When it is required to throw the light upwards (to light a ceiling, for example), the lamp can be simply reversed and the carbons pushed by means of springs. But an ingenious experiment made by the inventors enables us to suppress these springs. If we substitute for the movable carbons two rather large-sized blocks of carbon, these blocks will be gradually consumed, until the arc becomes too large and the lamp goes out ; the duration of the lighting is sufficient for a certain number of purposes, and this is the model used in the experiments at the Opera.

Besides the incandescence to which it gives rise, the refractory substance opposes the extinction of the lamp and contributes to it great steadiness. In fact, extinctions may be caused by the cooling of the arc, and this cooling is prevented by the incandescence of the block. This accounts for the fact that with the lampe-soleil an arc is obtained the length which may amount to four centimetres, which is not the case with other kinds of burners.

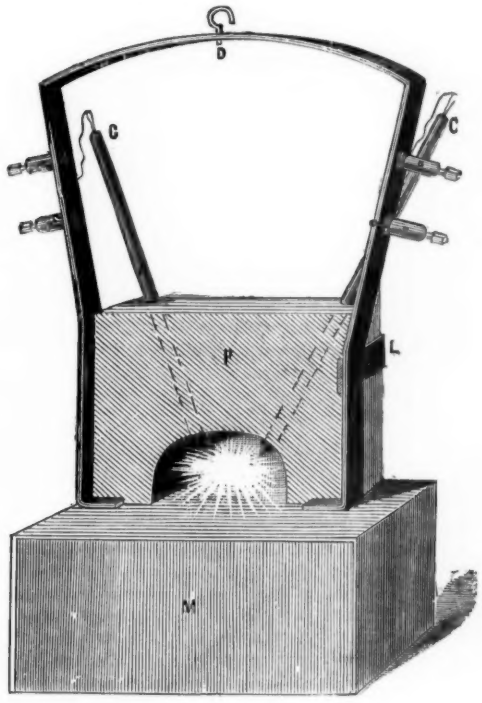


FIG. 2.

Want of steadiness arises in those lamps in which the distance between the extremities of the carbons is constant, from the shifting of the arc along the carbons. In the lampe-soleil, the arc being guided, these displacements cannot occur, and the fixity is complete.

While possessing these two good qualities, the lampe-soleil seemed to have the defect of being very noisy, as much in consequence of the usual hissing of the arc, as from the humming arising from the use of alternating current machines ; this fault has been remedied by placing the lamp in a space completely closed up by its frame and globe.

With the large carbons employed in the lampe-soleil, the consumption is very slight ; it is about 15 millimetres per hour for both carbons ; a long duration of lighting can therefore be obtained with comparatively short carbons. But it is important that the blocks of refractory material should also last a considerable time, and this is why the attention of the inventors has been specially directed to this point. They have succeeded in constructing blocks having a duration of 30 to 35 hours. In order to arrive at this result, they resolved to submit these refractory substances to a preliminary trial in an apparatus reproducing as far as possible the conditions in which these bodies are placed in the lampe-soleil.

This apparatus, shown in section and in perspective in figs. 2 and 3, consists of a block of refractory stone, M, on which is placed a second rectangular block, P, similar to that of the lamp itself, but much larger, and having a cavity underneath. The refractory substance is placed in

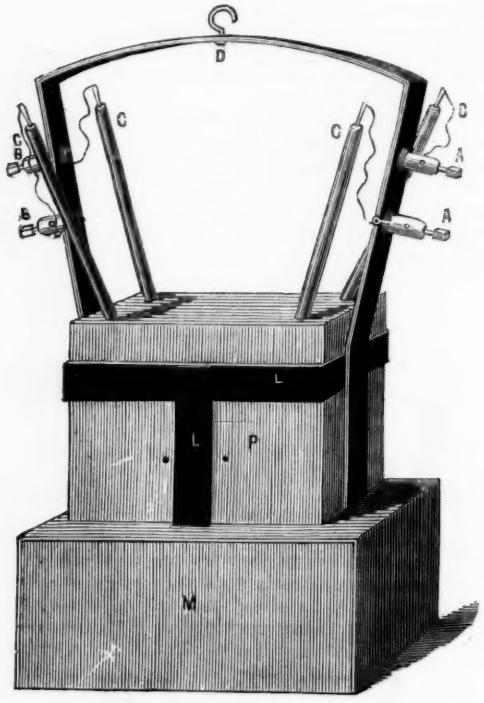


FIG. 3.

this cavity, and by means of four carbons, *c c c c*, a very powerful arc is produced in it. Thus the substance to be tried is submitted to the same temperature as that of the lamp, and it can be observed whether it acts well under these conditions. The lampe-soleil is generally worked by alternating current machines, such as the Gramme, and particularly the Lachaussée-Lambotte machine. This last machine allows of the current being divided into several circuits, each containing several lamps in a series. The installations are made in a similar manner to those of the Jablochkoff candles, and by means of commutators one circuit can easily be substituted for another very quickly.

Although the chances of extinction are very slight, it has been thought advisable to provide as far as possible against accidents of this kind, and M. Maquaire has with this object designed an automatic commutator, shown in fig. 4. In this apparatus three circuits, containing any number of lamps, are connected to the terminals B″ B‴ and to the terminal, B⁴ᵛ, not shown in the figure. Beyond the lamps these circuits are united in a single conductor in communication with one of the poles of the machine. The other pole is connected to the terminal, B, which is itself in communication with the frame supporting an electro-magnet of thick wire, E. The frame is joined to one end of the wire of the electro-magnet, and the other end is connected with the terminal, B′. The latter is in connection with the spring, H, which rubs on an axle, R, bearing three toothed wheels, R′ R″ R‴; these toothed wheels are arranged in such a manner that, for each position that the axle can take, one of these wheels, but only one, shall be in communication with one of the springs H′ H″ H‴, which are connected respectively with the terminals, B″ B‴ B⁴ᵛ.

The current of the machine on reaching B arrives at the frame, passes through the electro-magnet, E, returns to B′, then traverses successively the spring, H, the axle, R, the wheel, R″, the spring, H″, and the circuit in connection with the terminal, B‴, after which it returns to the machine.

As soon as the current is established, the electro-magnet, E, attracts an armature bearing an arm which puts the frame in communication with the insulated pillar, T. As long as the lamps are working and the current is passing through the electro-magnet, E, this armature remains attracted, but if an interruption takes place in the circuit, the current ceases to pass into the electro-magnet, E, the armature falls and puts the insulated pillar, T, in communication with the frame. The current entering at B thus arrives at T; then it passes into an electro-magnet of fine wire connected to earth, and returns to the machine by a second earth-wire. It results from this current that the armature, A, of the electro-magnet, E′, is attracted, and this attraction makes the axle, R, advance one tooth and establishes its communication with a second spring, H′, for example, and consequently with a fresh circuit. The current arriving at B is thus divided at first between the earth-circuit and that which has just been re-established, but as soon as it passes into E the armature of that electro-magnet is attracted, the contact at T, is cut off, and the current then only passes through the lamps.

It is seen that the lampe-soleil combines all the conditions required for good working; it now remains for us to examine the question of cost.

As regards the consumption of material, it is very slight.

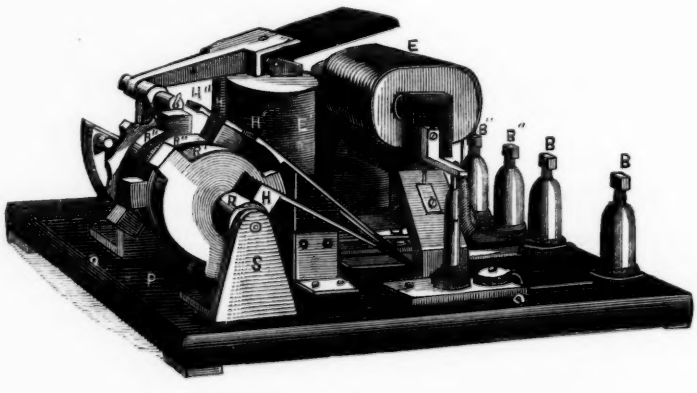


FIG. 4.

The calcareous blocks cost 30 centimes each, finished complete, and, thanks to the employment of wicks for relighting, they can be used several days in succession, especially when enclosed so as to be protected from damp. The cost per hour would not, therefore, exceed one centime per block. As also the consumption of the carbons is very slow, the total cost per hour of the lamp itself may be estimated at three centimes.

As to the expenditure of force, we think we may refer for information on this point to the report made at Brussels in September, 1881, by Messrs. Bède, Dumont, Rousseau,

Wauters, and Desquin. The accompanying table gives the summary of the experiments made by these engineers with an alternating Gramme machine, actuated by an exciter which absorbed 4·5 horse-power.

| DATE. | No. of Revolutions Gramme Machine. | Horse-power employed. | Resistance introduced in the Circuit of Lamps, in Ohms. | Intensity of the Current in the Circuit, in Ampères. | Number of Lamps. | Nature of Lamp. | Maximum Luminosity, in Carcels. | Number of Carcels per Horse-power. | Horse-power per Lamp. |
|---|---|---|---|---|---|---|---|---|---|
| June 13, 1881... | 1920 | 7·9 | 3 | 10·5 | 2 | 30 mm. | 280 | 70 | 3·9 |
| „ „ „ | „ | 8·1 | ... | ... | 3 | 22 „ | 212 | 78 | 2·7 |
| Aug. 3, 1881... | 1959 | 13·9 | ... | 5·5 | 12 | 11 „ | 105 | 90 | 1·16 |
| „ „ „ | „ | 11·7 | ... | 5·0 | ... | 11 „ | 100·5 | 103 | 0·97 |
| „ „ „ | „ | 13·9 | ... | 5·8 | 8 | 22 „ | 126 | 72 | 1·7 |
| „ „ „ | „ | 7·3 | 9·5 | 5·0 | 4 | 22 „ | Undetermined. | 72 | 1·8 |
| „ „ „ | „ | 15·8 | ... | 9·6 | 6 | 22 „ | 234 | 88 | 2·6 |
| Aug. 13, 1881... | 1986 | 18·0 | ... | ... | 16 | 11 „ | ... | ... | ... |
| „ „ „ | „ | ... | ... | 5·7 | ... | 11 „ | 113 | 100 | 1·1 |
| „ „ „ | „ | 18·8 | ... | 5·1 | ... | 11 „ | 89 | 75 | 1·2 |
| „ „ „ | „ | 18·3 | ... | 5·0 | ... | 11 „ | 70 | 61 | 1·1 |
| „ „ „ | „ | 18·0 | ... | 4·3 | ... | 11 „ | 60 | 53 | 1·1 |
| Aug. 20, 1881... | 2060 | 19·7 | ... | 12·0 | 12 | 11 „ | 140 | 85 | 1·6 |
| „ „ „ | „ | 19·0 | ... | 11·8 | ... | 11 „ | 126 | 79 | 1·6 |
| „ „ „ | „ | 17·9 | ... | 12·3 | ... | 11 „ | 120 | 80 | 1·5 |
| „ „ „ | „ | 16·5 | ... | 11·0 | ... | 11 „ | 85 | 61 | 1·4 |
| „ „ „ | „ | 15·5 | ... | 9·05 | ... | 11 „ | 66 | 51 | 1·3 |
| „ „ „ | „ | 9·4 | 4·8 | 8·13 | 3 | 30 „ | 205 | 65 | 3·1 |
| „ „ „ | „ | 7·0 | 9·5 | 6·9 | ... | 30 „ | 180 | 77 | 2·3 |
| „ „ „ | „ | 6·5 | 13·4 | 6·4 | ... | 30 „ | 165 | 76 | 2·2 |
| „ „ „ | „ | 7·2 | 22·9 | 5·8 | ... | 30 „ | 145 | 60 | 2·4 |
| „ „ „ | „ | 7·8 | 55·3 | 4·6 | ... | 30 „ | 98 | 37 | 2·6 |
| „ „ „ | „ | 3·8 | ... | 22·8 | 2 | 35 „ | 612 | 139 | 4·4 |
| „ „ „ | „ | 8·1 | ... | 22·3 | ... | 35 „ | 562 | 138 | 4·0 |

From the results set down in this table, and from their various experiments, the above-named committee have drawn the following conclusions:—

I. The luminous intensity at the commencement of the lighting is very high; it diminishes for about half an hour, and afterwards remains almost constant

II. The intensity of the electric current also undergoes a diminution, which is about proportional to the diminution of luminous intensity.

III. The experiments made on August 20th show that the lighting can be effected at very great distances from the factory where the current is produced.

IV. The motive force varies according to the electrical and luminous intensities:—

*a.* For lamps of 11mm., it varies from 1 to 1½ horse-power.
*b.* „ „ 22mm. „ „ „ 1·7 to 2·7 „
*c.* „ „ 30mm. „ „ „ 2·2 to 3 „
*d.* „ „ 35mm. it amounts to 4 „

V. The luminous result per horse-power is higher in proportion for large lights than small ones. Thus for lights burning with currents of 10 webers the result was on an average 70 carcels per horse-power; with two lights of 35mm. burning with 32 webers, it amounted to 138 carcels.

We see, therefore, that the lampe-soleil does not absorb a greater force than other lamps.

Summing up, if we consider the advantages offered by the lampe-soleil, we shall find that it is distinguished:—

I. For its simplicity. The absence of all mechanism renders its working perfectly regular; and in the various applications for which it has been used no extinctions have, to our knowledge, taken place. This is an important quality, and certainly one that every inventor should try to give to his apparatus.

II. For the steadiness of its light. This quality, of slight importance when it is a question of lighting streets and large spaces, becomes, on the contrary, highly important when interior lighting is required, such as the illumination of halls or workshops. We may, in short, imagine that variations which would be unnoticed in the lighting of a street, would be unendurable in a room where any work was going on.

The steadiness of the lampe-soleil renders it very suitable for the lighting of workshops, and the trial recently made of it in the printing room of the *Moniteur* has been received with great satisfaction by the compositors. With this system of lighting their work was done without fatigue to the eyes and without that intolerable heat which results from the employment of a large number of gas jets. The want of a suitable space for the generating machine has unfortunately put a stop to this lighting, but the trial has nevertheless shown the advantages offered by it from the point of view of the work and the comfort of the workmen. Let us add that the light of the lampe-soleil contains few violet rays, and is consequently one of the least fatiguing to the sight.

III. For the absence of noise. Although this quality arises from the fact that the noise of the lamp is disguised by an artifice of construction, this does not prevent it from constituting an important advantage in interior lighting.

IV. For its elasticity. By this we mean that the arc being protected against cooling can be maintained by a current, the intensity of which varies within rather wide limits, and the speed of the generating machine may vary twenty per cent. without the lamp being extinguished. The intensity will be diminished perhaps, but the arc will be maintained. This elasticity will allow the intensity to vary to a certain extent, which might be useful in theatrical applications, for example.

Finally, according to the inventors, this quality may also be turned to account for lighting at a distance more or less considerable from the generator. We may, in fact, obtain a given quantity of light in two ways, either with a small piece of marble and a high electrical intensity, or with a large piece of marble and a low intensity. These advantages, together with the fact that the light is produced under conditions of expenditure at least as favourable as those of other systems, lead us to consider it a system likely to enter most extensively into practice.

In fact the lampe-soleil has already made an excellent *début*, and has been put to several applications; and it has lighted successfully the picture gallery of the exhibition. We know how favourable this has been to the lampe-soleil, especially when the result obtained was compared with the experiments in lighting the coloured pictures in the Salon de Peinture a few years ago. During these experiments the light thrown on the pictures was of a ghastly tint, which communicated to the colours a certain tone, and these pictures, which were very effective by daylight, presented at night a most disagreeable appearance, so that the light had to be given up. With the lampe-soleil, on the contrary, the light is warm without being too yellow. The tone of the colours is very little different from that which they present by daylight, and the effect upon the eye is very agreeable. There is every reason to believe that if the experiments tried a few years ago at the Salon were recommenced with this system, they would be crowned with complete success.

At the exhibition, one of the pictures exhibited was lighted from below by a lamp reversed, and from this we can form an idea how advantageous this system would be for the lighting of ceilings. The trial at the Opera House has confirmed the success of this first experiment.

We may also mention the lighting of the Taverne Royale, at Brussels, where the light is produced by two lamps with opal globes, and the lighting of the Panorama at Westminster, in London, both of which were attended with equally satisfactory results.

For the above information, together with the illustrations, we are indebted to our contemporary, *La Lumière Electrique*. This lamp has, however, been tested again in London, during the last month, in connection with the Lambotte-Lachaussée machine, each lamp having its own bobbin on the machine for supplying the necessary current. It is said that each lamp and bobbin inserted consumes about 1 horse-power per 1,200 candles. We believe these machines are constructed with twelve bobbins, and therefore each machine will supply the current for twelve lamps. This high efficiency of the Lampe-Soleil may probably be due to the incandescent marble becoming a magazine of heat, the non-luminous rays being utilised for heating up to lighting point the solid matter which they strike, instead of being dissipated as in ordinary arc lamps.

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ROYAL SOCIETY.—At the meeting of the Royal Society last week, the 15 undernamed candidates were elected Fellows:—Professor Valentine Ball, M.A., George Stewardson Brady, M.D., F.L.S., George Buchanan, M.D., Charles Baron Clarke, M.A., F.L.S., Francis Darwin, M.A., F.L.S., Professor William Dittmar, F.C.S., Walter Holbrook Gaskell, M.D., Richard Tetley Glazebrook, M.A., Frederic Ducane Godman, F.L.S., Professor Jonathan Hutchinson, F.R.C.S., Professor Archibald Liversidge, F.G.S., Professor John C. Malet, M.A., William Davidson Niven, M.A., Robert Henry Inglis Palgrave, F.S.S., Walter Weldon, F.C.S.

# FACTS AND OBSERVATIONS RELATING TO THE INVENTION OF THE SUBMARINE CABLE AND TO THE MANUFACTURE AND LAYING OF THE FIRST CABLE BETWEEN DOVER AND CALAIS IN 1851.

[We have received the annexed paper in the form of a pamphlet, and we consider it sufficiently interesting to reproduce in full.]

1. A paper, dated Paris, October 11th, 1881, and addressed by M. Bede to M. Dumas, Membre de l'Institut, Président du Jury du Groupe 1 de l'Exposition Internationale d'Electricité à Paris, has lately come into my possession.

2. It is chiefly composed of extracts from papers which have been read at the Institution of Civil Engineers, London, which contain statements very much at variance with the truth, and credit has been given to those to whom it was not due, while it has been withheld from those who most deserved it, and regarding whom the most false statements have been made.

3. Before dealing with these misstatements I must narrate some facts connected with the invention of the submarine cable, which date prior to the misstatements.

4. I believe that I had in my possession some of the first specimens of gutta-percha that ever came to this country. They were sent from Sumatra by Mr. John Colville in 1837. No one was then aware of the valuable property of insulation afforded by gutta-percha, which, I believe, was first published by Faraday, in a letter dated February 9th, 1848, published in the *Philosophical Magazine* on *March 1st*, 1858. This attracted my attention; for at that time I was asked to advise as to the best means of carrying a line of telegraph across the Hudson river between New York and New Jersey.

5. *On March 15th*, 1848, I wrote a letter suggesting two plans, one to cross by a wire cord suspended on high poles and in one span of 5,000 feet; and the other plan in the following words: "We cannot but think that the cheapest plan would be to lay the wire across the river *under* water. We believe it might be coated so as to insulate it completely."

6. This, so far as I am aware, was the first suggestion of a submarine cable, and it was made by me.

7. Shortly after writing the above letter, I made a piece of wire cable which had as a core four copper wires insulated in one mass of gutta-percha. I afterwards made another piece containing four separately insulated copper wires.

8. *On August 28th*, 1850, a copper wire, insulated in gutta-percha, about half an inch in diameter, of less specific gravity than water, but kept down by leaden weights attached every 1-16th of a mile, was submerged between Dover and Cape Grisnez, near Calais, by Messrs. Brett, Reid, Wollaston & Edwards. This lasted one day, until it was broken by chafing on the rocks. It served the purpose of proving that messages could be conveyed across the channel by means of electricity.

9. In July, 1850, Mr. Robert McCalmont published (by Trelawney Saunders) a pamphlet on steam communication between England and Ireland by means of express boats; and

10. *On September 19th*, 1850, he published a second edition, with a postscript containing the following statement:—

"Since the foregoing statement was published, a plan of forming submarine telegraphs has been suggested by Mr. Newall, of Gateshead, which is so likely to be successful that the establishment of message boats between Donaghadee and Port Patrick will probably be unnecessary. *He proposes that the gutta-percha lines containing insulated wire should be surrounded with strong wire rope;* that a rope of gutta-percha cords, with their insulated wire wicks, should, in fact, constitute the core of a strong wire cable, to lie at the bottom of the sea."

"The assumption in my letter of July 13th, that a durable submarine telegraph would be impracticable, I now judge to be erroneous, and consequently the part of my letter founded on that assumption falls to the ground. *It will soon be tried.*"

11. After the failure of the experimental wire in August, 1850, my partner had several meetings with Mr. C. J. Wollaston, the engineer of the Anglo-French Telegraph Company, and

12. *On September 19th*, 1850, we sent to him in Paris a piece of submarine cable which he had been shown at our office in London, and which he wished to show to the President of the French Republic; and it was on seeing this specimen that the concession was renewed. We gave Mr. Wollaston all the information he required, on the understanding that we were te be employed to manufacture the cable.

13. *On June 4th*, 1851, we sent him a tender for covering with ten galvanised iron wires of 5-16ths diameter twenty-three miles of core, containing four insulated wires, which he was to supply. In our tender we say, "We can do the twenty-three miles now required in two months from the time of receiving the order, or even in less time, if required; but we would like as long notice as possible, in order to prepare the wire." To this we got no reply.

14. *In* , 1850, I had obtained an injunction against Wilkins and Weatherly, ropemakers, for infringing my patent for machinery for making wire rope, and their works were consequently closed.

15. *On July 29th*, 1851, I was informed that Mr. T. R. Crampton, whose name I heard for the first time in connection with submarine cables, had contracted with Mr. Edward Weatherly, a clerk in a Proctor's office in Doctor's Commons, and nominally the successor of Wilkins and Weatherly, to make the cable for the Dover and Calais line. I also heard that a machine had been ordered from a north country mechanic on July 15th for making a submarine cable, but it was to be arranged that it would *put a slight twist into each of the* 10 *wires* which it was to lay round the core. This was done by having one tooth fewer in the ten outside wheels than was in the central fixed wheel, *with the view of evading my patent!* which was for preventing all twist of the individual wires and laying them round a core. This suggestion of Mr. Crampton's when carried out, as it was before we got hold of the machine, proved that neither he nor Weatherly understood wire-rope making, for the twist accumulated in the wires, and actually twisted them in two, and also prevented them from lying close together, as they do in my patent rope. We therefore had to change the wheels before we could work the machine.

16. *On August 5th*, 1851, I obtained an injunction *v.* E. Weatherly, restraining him from infringing my patent; and as the concession for telegraphic communication between France and England would lapse unless the cable were laid before September 30th, Mr. Crampton found himself compelled to arrange with me for its manufacture. My firm therefore undertook to manufacture it on the premises of Wilkins and Weatherly, which we hired for the purpose, and we brought our men from Gateshead, and took over part of the materials which had been contracted for. We found it necessary to erect an additional steam engine, and had to alter the machinery, which was of the very roughest description, and constantly breaking down, causing great delay in repairs. We however started on August 28th, and made one mile; next day, 900 yards; on the 30th, 1,060 yards, working night and day; and on September 24th we had completed the twenty-four miles contracted for. It was shipped by noon on board the *Blazer*, and within an hour the vessel was under weigh and being towed down the river.

17. We had nothing whatever to do with the laying of the cable. It was so managed by Mr. Crampton that, although the sea was as smooth as glass the whole day of September 25th, from 4 o'clock in the morning, when he started to lay the cable, until 6 p.m., when he arrived near the French coast, about a mile from the shore, all the cable was paid out. This was not to be wondered at, seeing that he had no proper apparatus for controlling the paying out of the cable. We supplied him with an additional mile of cable, and the line was completed on October 17th, 1851, and opened for the transmission of messages about November 13th, under a concession for ten years, granted on October 23rd, 1851, by the French Government to Lord de Mauley, the Hon. F. W. Cadogan, Sir James M. Carmichael, and John W. Brett.

18. In a paper read by Mr. Window at the Institution of Civil Engineers, London, on July 13th, 1857, he states: "Mr. Crampton professed confidence in the feasibility of

the scheme, and engaged not only to put the mechanical and engineering portion to a practical shape, on his own responsibility, but to provide one-half of the necessary capital." And in the quotation given by M. Bede in his "Observations" at the bottom of page 26, Mr. Crampton is reported to have said at the discussion of Mr. Window's paper: "Messrs. Davis & Campbell, the solicitors, having confidence in Mr. Crampton's representations, offered to provide three-fourths of the capital, if he, Mr. Crampton, would subscribe *one quarter* and undertake the direction of the enterprise."

19. I meet this by the following statement. We were assured both by Mr. Crampton and Mr. Wollaston that the capital of the Submarine Company would not exceed £25,000, and on that assurance we agreed to take in part payment of our contract,

| | | | |
|---|---|---|---|
| Paid-up shares .. .. .. .. .. | | £4,000 | |
| On September 1, 1851, we received from Mr. Crampton cash .. .. .. | £500 | | |
| On October 1 do. do... .. | 500 | | |
| On November 1 do. do... .. | 500 | | |
| | | £1,500 | |
| On November 1, 1851, Crampton's acceptances at 3 months, due 1/4 February .. .. | | £3,000 | |
| | | £8,500 | |
| Cash for one mile of cable supplied October 7 | | 370 | |
| | | | £8,870 |
| To this has to be added the cost of the gutta-percha wires .. .. .. .. .. | | £2,800 | |
| And the cost of laying down and land connections, say .. .. .. .. .. | | 1,000 | |
| | | | £4,760 |
| Total cost .. .. .. .. .. | | | £13,630 |

From the above statement it will be seen that we advanced more than half the cost of the cable.

A company was registered in 1849 with a capital of £25,000, of which Wollaston, Edwards & Brett were to have £10,000 for giving up the French concession, for certain expenses, and for the use of Brett's printing telegraph. £5,000 in shares were taken up by the public.

20. In 1851, August 15th, a general assembly of shareholders (the public £5,000, and Wollaston, Edwards & Brett £10,000) was held, and they voted modifications of the original deed and proceeded to register a new deed, altering the capital from £25,000 to £100,000, of which £50,000, instead of £10,000, was allotted free to Wollaston, Edwards & Brett. We were not told of this until October 17th, after our contract was completed. We were glad to get out of such company by selling our £4,000 shares.

21. In the discussion which followed the reading of Mr. F. C. Webb's paper on July 23rd, 1858, Mr. Crampton stated, "The operations were commenced on a calm day, but shortly a strong gale came on, and the towing rope parted, the vessel holding on to the cable on board, drifting about 1¾ mile down the channel before it was again taken in tow."

I was at Dover the whole day of the laying down, and can certify that the gale came on the next day!

22. Mr. Crampton also stated, in the discussion which followed Mr. Window's paper of July 13th, 1857 (p. 25 of M. Bede's "Observations"):

(1) "He was, in fact, the first to realise an important project, whereby the world, by common consent, was materially benefited."

(2) "No single individual, however, could execute a work of that kind in seven or eight weeks, and he had great pleasure in acknowledging the material assistance he received from Mr. Wollaston, an early labourer in the field."

(3) "And also from Messrs. Wilkins & Weatherly, who contracted for the manufacture of the cable."

(4) "And designed in so short a time the machinery for constructing it."

(5) "This machinery answered perfectly, although it was considered impracticable by Mr. Newall and Professor Gordon, who were supposed to be best acquainted with such matters."

(6) "The manufacture of the cable was proceeding most satisfactorily when, owing to circumstances to which it was unnecessary further to allude, it passed into the hands of Messrs. Newall & Co., by whom the same machinery and workmen were employed."

These six statements of Mr. Crampton are each and all simply untrue.

The first is contradicted by paragraph 10, if not by paragraph 8.

The second is contradicted by paragraph 13, where we offer, in June, 1857, to complete 23 miles of cable in seven or eight weeks.

The third is contradicted by paragraph 14. There was no contract with Wilkins & Weatherly, who (fourth) had pirated my machinery.

The fifth and sixth are contradicted by paragraph 15.

23. At pages 17 and 29 of M. Bede's "Observations," Mr. Preece is reported to have said, at a meeting of the Society of Telegraph Engineers of London in 1876, "Mr. Crampton was the man who found half the capital and means, and had the spirit and courage to submerge the first actual cable between England and France; and more than that, he was the means of designing and adopting that form of cable which has never been departed from. The wire rope constituting the first cable characterises every one laid since. Mr. Crampton's wire rope remains the type of all submarine cables."

24. I presume that Mr. Preece, when he knows the facts which I have here stated, will not give the credit to Mr. Crampton for all that I did prior to the laying of the Dover and Calais cable, and that he will render me credit for what I have done since in matters connected with submarine telegraphy, viz., the invention of efficient break apparatus for laying cables, and the mode of landing the shore ends by means of empty barrels instead of a great number of boats and men, and my invention of the mode of coiling cables in circular tanks, with a central cone and rings, which has been extensively pirated by Messrs. Glass and Elliot, who, after losing the first cable they contracted to lay, used my apparatus in laying every cable they afterwards made, and against whom I obtained repeated verdicts for infringing my patents. They were followed by the Telegraph Construction Company, Mr. John Pender, chairman, against whom I also obtained verdicts. Mr. C. W. Siemens and the Silvertown India-rubber Company have used my apparatus in all their expeditions; in short, no cable has been laid since 1854 without my apparatus; and the cables, almost without exception, have been based on my invention of wire rope.

25. The article from the *Times* of September 25th, 1881, given at p. 29 of M. Bede's "Observations," was written by the *Times* correspondent when reporting on the late Electrical Exhibition in Paris.

26. I wrote to him, pointing out the great mistake he had made in his statement, viz.: "Too great credit can hardly be paid to the man who thus completed so desirable an object. Immediately afterwards a well-known firm failed in three attempts to connect England with the Continent; and had these failures occurred before Mr. Crampton's success, it is difficult to conjecture how long it would have been before submarine telegraphy would have been looked upon as feasible."

27. We did not fail in any attempt to connect England with the Continent. On the contrary, we laid with the most perfect success a heavy cable, containing seven insulated wires, from Dover to Ostend, on May 6th, 1853. (See *Illustrated News*, May 14th, 1853.)

28. It is not true, as stated in Mr. Window's paper, quoted at the bottom of p. 21 of M. Bede's "Observations," that "Messrs. Newall, the contractors for the Ostend cable, offered a large sum of money to be released from the responsibility of laying it down; but on Mr. Crampton, at the time one of the engineers of the company, offering to undertake it, the operation was subsequently performed by the contractors with perfect success."

29. The truth being that we refused to lay it down in the stormy weather of December unless the directors would agree to pay the extra premium demanded by the underwriters for insuring it at that season.

30. We laid three cables successfully between England and Holland, a distance of 120 miles, for the International Telegraph Company in 1853.

31. I have already corrected some of these misstatements nearly thirty years ago (see *Times*, November 12th, 1852), and hope this is the last occasion I shall have to do so.

R. S. NEWALL.

Gateshead, *May 22nd*, 1882.

# MAGNETO-ELECTRIC MACHINES.

As a rule when the daily press has attempted to give a description of any part of the apparatus connected with electric lighting, the result has been a miserable failure as far as descriptions of a scientific nature were concerned. In fact the inaccuracies contained in the ordinary newspaper reports of different systems of electric lighting, whether of machines, lamps, or minor details, has often been a sore point with the inventors of the apparatus so described. We are therefore always glad to see any attempt made to clear up such misleading statements as generally come forth from the general reporter, and we observe that the *Times* of the 13th inst., probably with this view, devotes more than three of its columns to the enlightenment of its more interested readers in the mysteries of dynamo-electric machines. This article, taken as a whole, is considerably in advance of any similar endeavour to simplify the means of understanding the subject upon which it treats. There are, however, several instances of the writer's misconception of his information which it may be well to point out. After speaking of permanent magnets and electro-magnets, the article continues :—

> The electro-magnets may either receive their current from a separate source or may be fed with the whole or a part of the current which the machine itself produces. In the former case the machine is said to have a "separate exciter," in the latter it is called a "dynamo" machine. The great majority of the machines in use are dynamos, and in most of them the whole current produced traverses the coils of the field magnets.

We should have considered it more correct to state that all such machines, converting by motion mechanical into electrical energy, would be classed under the head of dynamo-electric machines. The "separate exciter" of the writer is actually identical with that which he is pleased to call a "dynamo." In his explanation of alternating currents and machines for producing them, he speaks thus of the Lontin system :—

> In the Lontin machine the cores are all perpendicular to the axis of rotation, the armature magnets standing out, like studs, on the convex surface of a revolving cylinder, while the field magnets project from the inside of a surrounding hollow cylindrical frame.

This description is apparently a mixture of the alternating current machine of Lontin and his *continuous current* "exciter" for producing the magnetism in the revolving electro-magnets of the first-mentioned machine, unless we have mistaken the meaning of the paragraph ; or it may be that the order of things has been unintentionally reversed.

In the Lontin system the machine for producing the alternating currents for the lamps has a number of the electro-magnets fixed on a cylinder or hub perpendicular to the axis of rotation and revolving with it. The ends of these electro-magnets are so arranged by the coiling of the wire as to be alternately north and south, when there is passed through them a continuous current from the "exciter." Surrounding these electro-magnets is the hollow cylindrical frame, from which project internally other smaller and fixed electro-magnets, which have currents of alternate direction induced in them by the revolving *field* magnets. In the succeeding sentence we read that :—

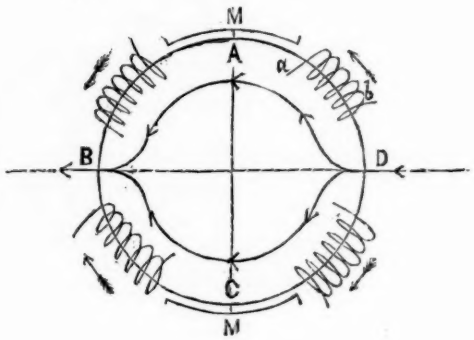
> Alternating currents have an advantage for the purposes of the ordinary arc light, for the positive carbon is consumed much faster than the negative, and there is difficulty in preserving a proper balance between the two carbons when the current is always in the same direction ; but when we have alternating currents of precisely equal strength and duration, the two carbons wear away equally. This consideration is specially important when the light is to be in the focus of a lens or mirror, as unequal consumption of the carbons, if not exactly compensated (which is very difficult in practice), throws the light out of the focus. Hence it is easy to understand that alternating currents are always preferred for lighthouses.

We think that the true reason of the preference for alternating currents is in the fact that by this means the light is thrown out more equally all round by the carbons both becoming pointed, whilst in the lamps used for continuous currents the light is to a great extent thrown up or down, as one may choose to use the positive carbon above or below.

After a very fair general description of the well-known Gramme machine, the writer then explains its action in such a way that we consider a diagram illustrating his meaning will be found acceptable by many of our readers. The production of a continuous current in the Gramme armature is shown thus :—

> The two poles of the ring constantly occupy the same positions in space, though they occupy in succession all the points of the ring. The effect upon the coil is accordingly the same as if the iron core were at rest and the coil sliding upon it. A current is induced in the coil in one direction at the part which is passing the north pole and in the opposite direction at the part which is passing the south pole. Let us consider four points, A, B, C, D, 90 degrees apart round the circumference, and let A and C be the two poles at the moment considered. Then a current is flowing through A in one direction round the coil, say, the direction D, A, B, and a current is flowing through B in the opposite direction, D, C, B. The currents then are from D to B in both halves of the ring, and the two collecting brushes must rub, one of them against a segment connected with D, and the other against a segment connected with B. In practice the commutator has a large number of segments, and each brush makes contact with two or three consecutive segments at once. The two places for collecting the currents, or the two poles of the armature considered as a source of electricity answering to the two poles of a battery, are, it will be observed, as far as possible from the two magnetic poles, the latter being at the ends of one diameter of the ring, and the former at the ends of a diameter at right angles to it. This was clearly understood by Paccinotti, the first inventor of the ring armature, whose original machine, a rough laboratory model, attracted much attention at the Paris Electrical Exhibition. Paccinotti constructed his machine in 1860, and described it in an Italian magazine in 1864, but it remained unknown to the world in general till its principle was re-discovered a few years ago by Gramme, who was at that time a workman at Paris, and applied by him to important commercial uses. The Gramme machine immediately obtained a very high place in public favour, which it still retains.

Let us take a diagram (see figure below) with all the points as set forth in the *Times*, and we shall be able to follow its meaning with greater ease.




We will take, for sake of example, only four coils on our ring, and, as the action of the Gramme machine is actually as if the iron ring were stationary and the coils sliding over it, we will start with the top-right-hand coil, *a*, *b*, and suppose it to be travelling towards the left. As the point, *a*, approaches the pole, a current will be set up in the coil in, say, the direction of the arrow. Now if we passed this coil along the iron ring so that its end, *b*, was receding from the pole, a current would be generated in the same direction as when *a* was approaching, therefore it will be clearly seen that all the coils in the upper half of the ring have currents in the same direction and as indicated by the arrows. Suppose next that the coil was sliding along the lower half of ring and its end, *a*, approaching the lower pole, which is of opposite polarity to that above, we should then generate a current in the opposite direction to that flowing in the upper half, and as the coil receding from the lower pole produces a current in the same direction as when approaching, it is evident that the currents in the two halves of the ring flow in the directions respectively of D, A, B, and D, C, B. In the figure M, M, represent the pole pieces of the field magnets. It may be well to mention here that the armature of a self-exciting machine must be revolved always in the same direction to produce a current, a reverse action destroying all traces of any current, unless the residual magnetism of the field magnets has been subjected to a

change of polarity. Thus an armature, which is always revolved from right to left when working, would not produce any current when turned in the opposite direction, because the residual magnetism of the field magnet, instead of being increased by reaction would be destroyed entirely. We may also add in reference to alternating current Gramme machines, that we believe they *all* have a fixed ring with revolving electro-magnets to induce the currents for producing the light.

The description given of Siemens' machine is very good, and the difference in the methods of winding the sections of insulated copper wire on the Gramme and Siemens rings respectively very clearly defined. The writer then goes on to describe the machines of Jablochkoff, Bürgin, Brush, and De Meritens. We do not think the Anglo-American Brush Electric Light Corporation will let the description of their machine—which is identified with that of Gramme—pass by without a protest.

Then follows the Edison machine, with its peculiar modifications of the Siemens' method of winding the armature, and the article ends with an explanation of the re-action principle.

It is a little curious that the writer, who has evidently been at some pains to construct his very readable and voluminous essay should have omitted all mention of Hjorth of Copenhagen, who had certainly discovered the principles on which our present dynamo-electric machines are constructed long before Paccinotti, on whom he sets great store. Paccinotti may have been the inventor of the *ring armature*, and no doubt was, but Hjorth certainly deserves more than passing mention when the subject of dynamo-electric machines is treated upon. The whole article, although ostensibly written for the benefit of the better informed general public, savours somewhat of a more than ordinary regard for the Gramme machine. However, be this as it may, we can, as they stand, congratulate the writer on having produced the best informed and with some exceptions the most accurate general descriptions of the numerous machines at present in use that we ever remember having seen in a daily newspaper. We would suggest that the same treatment should be given to the various arc lamps which have been invented, or at least those now in use; and the same remark might apply to lamps of the incandescence type in which the public is just beginning to take the greatest interest.

## THE GOVERNMENT ELECTRIC LIGHTING BILL.

THE Select Committee of the House of Commons, which has been considering for some weeks past the Government Electric Lighting Bill, resumed its sittings on Thursday the 8th inst., under the presidency of the Hon. E. Stanhope. When the Committee rose for the Whitsuntide holidays they had presented certain resolutions, and they invited the Gas companies, corporations (with and without gas undertakings), and the electric lighting companies to propose amendments. This was done; and the Committee now invited discussion on a draft bill as amended by the Board of Trade.

At the commencement of the proceedings, Mr. Littler, Q.C., stated that the corporations possessed of gas undertakings had met that morning and had resolved to withdraw from further appearance before the Committee, it being their opinion that they had not been fairly treated by the Committee, and they preferred to take action at a future stage of the bill.

Mr. Richards, Q.C., also withdrew the appearance of the gas companies before the Committee.

Mr. Pope, Q.C., then proposed clauses for the protection of railway and canal companies. He stated that they had three clauses, and two of them went on exactly the same lines as the clauses applicable to telegraph wires; but their third proposal went beyond these, and required that where the electric companies took up the roads now repairable by the railway or canal companies, the railway and canal companies should cease to be liable for their repair, and that responsibility should then devolve upon the electric lighting companies.

Mr. Rodwell objected that this was placing too much liability upon the electric lighting companies.

The Committee decided to give a clause providing for the removal of the wires placed in contiguity to any railway or canal if they were found to interfere with the business of a company or prevented necessary communication; and also to retain in the bill a provision which was in the original draft bill made by the Board of Trade, providing that the road authorities should have notice of intended works, and should be heard before the Board of Trade.

Mr. Pember, Q.C., proposed on behalf of the Mining Association of Great Britain, the incorporation of sections 18 to 27 inclusive of the Waterworks Clauses Act of 1847, which would give the electric lighting companies the option of surrendering the common law right of suing for damages in the event of subsidence of a mine, or the alternative of purchasing the mine where they proposed to lay their wires. The learned counsel further proposed a clause which would give mine-owners the power to disturb electric wires on their tramways or works on making proper terms by the electric lighting companies.

The Committee determined not to allow the incorporation of the proposed clauses of the Waterworks Clauses Act; but as to disturbance with the electric wires, a clause would be inserted in the bill meeting the views of the mining association.

Mr. R. S. Wright, on the part of the corporations who have no gas undertakings, desired a provision to be inserted in the bill which would preclude persons with electric lighting patents getting an exclusive licence for certain districts. He gave as an illustration the case of Mr. Lane-Fox, who obtained a patent for the distribution of light, which patent claimed with respect to any possible kind of generator at one end and any possible kind of burner, the use of the secondary battery, which, according to the evidence given before the Committee, was practically the only known means of distributing properly, effectively, and safely the electric light from the generators to the private houses. If that patent were held to be good, the obvious consequences would be that Mr. Lane-Fox, by granting to any one company or any one person, an exclusive licence to use the secondary battery in the district of Liverpool, for instance, could make it impossible for any other company or person whatever to enter into competition for any purpose that included domestic lighting, because, according to the evidence, the only way of working domestic lighting would be to use the secondary battery. Neither a corporation nor a private company who sought the privileges of this Bill ought to have an exclusive licence.

Mr. Moulton, on behalf of the electric lighting companies, said the proposal of his learned friend was really to alter, and to a great extent repeal the patent laws; and this must have been suggested by some enemy of the patent laws. There was no such thing as a patent giving the exclusive right to use secondary batteries. To his knowledge there were five patents for secondary batteries, and about thirty more which would be published shortly. The proposal would take away from a patentee not only the largest market, but the most remunerative market for his invention. There was no ground for such a piece of legislation, and he was certain the Committee would not adopt the proposal.

Mr. Wright urged in reply, that exclusive privileges were given over public and private property by this bill to electric lighting companies, and it was public policy to restrict this patent, otherwise the electric lighting system might be rendered wholly useless to the public.

The Committee disallowed the clause.

A proposal to make provision for all work of breaking up or interfering with streets being done by the local authority, for the undertakers, instead of by the undertakers, was considered by the Committee, and a promise made that a clause would be drawn to partially meet the proposed amendment.

On Friday the Committee again met, and Mr. Pember, Q.C., on behalf of the Mining Association of Great Britain, brought up some new clauses in lieu of those rejected by the Committee on the previous day. He proposed a clause which appeared in the Tramway Act of 1870: "Nothing in this Act shall interfere with the mines or minerals, across which a tramway should be laid to work such minerals, nor

shall any liability arise from working them in the usual and ordinary way of mining." They required more protection from these electric companies than the tramways, because in the case of the wires they would be nearer to the ceiling of the mines, and they would be of considerable weight; and if damaged the electric companies show consequential damage and loss of profit. If the Committee considered that that went too far he had another clause which would perhaps meet their views: "Nothing in this Act shall be construed to interfere with or obstruct the efficient working of mines, or to impose upon the owners, lessees, or workers of mines, any burden of support or liability in respect of electric lines or works, over or near to any mines unless such lines have been purchased, or the right of support expressly acquired by the undertakers." In order to make it perfectly clear that no immunity was given to the mine owners, but on the other hand that no fresh burden was imposed upon them, and that both the mine-owners and the electric lighting companies on the other hand should be left to their legal rights outside the statute, he recommended keeping the section as it was, but with this provision: "Provided always that this enactment shall not be taken to alter, lessen, or remove any liability which the owners, lessees, or workers of such mines, would otherwise have been subject to at common law, or under the provisions of any statute." Then, as the Committee were opposed to his amendment of clause 14, he had altered it, and it would now read as follows: "The owners, lessees, or workers of any mines of coal or other minerals, who at any time after the passing of this Act may have the right, and shall be desirous of making and constructing, altering, or removing any surface tramways in connection with the working of such mines or minerals, and for such purpose shall find it necessary to disturb, alter, or divert any electric line or other works of the undertakers empowered by this Act to be laid down or made, may at their own expense, construct, alter, or remove any such surface tramways or works; and for that purpose may disturb, alter, or divert any such works of the undertakers upon such terms or regulations as may be agreed upon, or in the case of difference, may be settled by an inspector of the Board of Trade." By that clause no one could alter the tramway or disturb a wire who had not previously the right to lay down a tramway.

The Chairman announced the decision of the Committee as follows: With respect to the first clause which Mr. Pember has proposed the Committee are not prepared to grant it in the terms in which he proposes it; but they will give it in the following form:—"Nothing in this Act shall limit or interfere with the rights of any owner, lessee or occupier of any mines or minerals lying under or adjacent to any road along or across which any electric wire shall be laid to work such mines and minerals." With respect to the other clause the Committee will not put it in the form in which Mr. Pember proposes it; but an amendment to Clause 9 will be moved by the President of the Board of Trade, which, if accepted by the Committee, will practically give all that is asked for.

Mr. Richards proposed an amendment on the part of the gas and water companies to give mutual protection against injury to the respective undertakings of the electric companies and the gas and water companies.

Mr. A. M. Sullivan also proposed clauses for the protection of tramway companies, chiefly directed to the question of notice.

Mr. Moulton having stated his objections on the part of the electric companies,

The Committee deliberated; and on returning to the room,

The Chairman said that in the case of the tramways the Committee did not propose to introduce any clause here on that subject, but they proposed to introduce a clause or an amendment of a clause which might have the effect of doing something like that which was applicable to the roadway authorities. With regard to the gas and water companies the case was sufficiently met by the bill as amended. The Committee again adjourned.

On Monday the clause proposed by Mr. R. S. Wright, proposing to enable municipal authorities to contract for the supply of electric light, was considered by the Committee and rejected. They decided, however, to substitute the following clause, which was agreed to:—Any local authority, who has obtained a licence, order, or special Act for the supply of electricity may contract with any company or person for the execution and maintenance of any works needed for the purposes of such supply or for the supply of electricity within any area mentioned in such licence, order, or special Act, or any part of such area; but no local authority, company, or person shall by any contract or assignment, transfer to any other company or person, or divest themselves of any legal power given to them, or any legal liabilities imposed upon them by this Act, or by any licence, order, or special Act.

An additional sub-section to Clause 2 was proposed by the Committee, and not being objected to by the electric lighting companies, was agreed to.

Other amendments were made, and the Bill ordered to be reported to the House.

## PROCEEDINGS OF SOCIETIES.

### PHYSICAL SOCIETY.—JUNE 10th.

Prof. CLIFTON, President, in the Chair.

New Member—Major-General MARTIN, R.E.

MR. W. F. STANLEY read a paper on "Sonorous Vibrations," especially those of the tuning-fork. The longer and more visible movements of a sounding body do not appear to be best fitted to propagate musical sounds, as was shown by placing discs on the prongs of a powerful fork, which when vibrating could then only be heard a short distance, whereas, by its smaller longitudinal motions when placed on its resonator it produced a penetrating sound. The vibrations down the stem of the fork was shown not to depend upon a vibrating ventroid as suggested by Chladni, for a fork cut in the end of a solid steel bar communicated sonorous vibrations equally well to the resonator. To set a fork in vibration it was necessary to bow one prong only, therefore in this case the vibration must proceed along the prongs. A light fork, one metre long, was fixed in a heavy vice, and it was shown by it that vibrations passed down one prong and up the other alternately. By means of dust, ripples were shown to run down an ordinary fork in vibration. Light pieces of metal were fitted to the ends of a powerful fork and these immersed in mercury, the reflected surface of which was shown on a screen, where it was seen that the whole mercury surface was broken into fine ripples. It was suggested that such small waves are also perceived by the ear. By these, certain conditions of harmonies could be better accounted for, as, for example, by division in smaller waves the rarefaction of a note in space would not suffer interference by the condensation of its octave falling in the same space and time.

Lord RAYLEIGH explained several of Mr. Stanley's experiments on the known theory of sound.

Mr. WALTER BAILY then exhibited a model of a new "integrating anemometer." This apparatus contains a horizontal plane in which are two slits forming a cross with arms towards the cardinal points. Each slit is fitted with a sliding piece, and the two slides are connected by a bar; the arrangement being that of the well-known instrument for drawing ellipses. The slides carry beneath them wheels with their planes perpendicular to the slits and passing through the pivots of the bar. The wheels rest on a horizontal disc, whose centre is beneath the centre of the cross. The centre of the bar is to be connected to a weathercock, which will keep it in the direction of the wind when looked at from the centre of the instrument. The disc is to be revolved by Robinson's cups. The number of revolutions of the wheels then give the integral of the resolved parts of the wind in the direction of the cardinal points. In the working model of the instrument exhibited, there was an electrical arrangement connected with four indicators, one for each of the cardinal points. At each turn of a wheel a circuit was completed and the corresponding indicator moved. Recording instruments are to be substituted for indicators, and the amount recorded on each in a given time will be proportional to the total motion of the wind towards the corresponding cardinal point. Mr. LECKY pointed out that a good anemometer was a great desideratum at present. The Society meets at Oxford on the 17th, and South Kensington on the 24th, of this month.

# NOTES.

MEXICAN CABLES EXTENSION. — The India-rubber, Gutta-percha, and Telegraph Works Company have received a telegram informing them that the ss. *G. E. Wood* has completed the laying of the cable she had on board, and is now on her voyage home. The telegram further stated that the ss. *International* had successfully landed the shore end at Galveston. All well on board.

THE ACCUMULATOR DISPUTES.—We have been requested to insert the following letter, and have pleasure in so doing:—

446, Strand, London, W.C.
June 7, 1882.

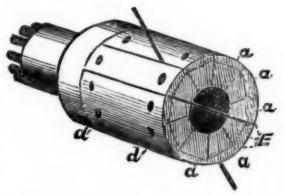
DEAR SIR,—I acknowledge, before we enter into our conventions, that you have given me full explanations upon the circumstances which have been, on my part, the object of personal attacks affecting your honour. I therefore retract every expression and every accusation which, publicly or otherwise, have been used by myself, or on my behalf, which could reflect in any way upon your honour.

From to-day we, on both sides, loyally put an end to any dispute or lawsuit between us.

Yours faithfully,
(Signed) S. PHILIPPART.

Monsieur E. VOLCKMAR,
74, Hatton Garden.

COMMUTATOR FOR MAGNETO-ELECTRIC MACHINES.—Patent No. 257,566, filed in the United States of America Patent Office, February 10th, 1882, by Arthur H. Eddy.




*Claim.*—1. In a commutator, the combination of the several insulated strips and the recessed head, into which they are forced and by which they are held together, substantially as described, and for the purpose specified.

2. In a commutator, the combination of the recessed head, the several strips having the shoulder, *b*, the bolt, F, and shaft, D, substantially as described, and for the purpose specified.

3. In a commutator-strip, the body, E, and wearing-plate, *a*, having their confronting sides made flat, as shown, and having the head of the deeply-slotted screw, *d*, sunk into the strip, *a*, nearly to the flat side of said strip, substantially as described, and for the purpose specified.

THE EDISON LAMPS AND THE FAURE ACCUMULATOR.—According to the *Electrotechnische Zeitschrift*, the General Direction of the German State Railways has caused the carriages to be lighted up by Edison lamps, supplied by Faure's accumulators, of which 30, weighing 360 kilos, kept an Edison lamp of 10 candle-power in action for 120 hours. The elements are charged during the day by the same machine which by night sets the Edison lamps in action at the Strasburg station. The accumulators have been constructed by the Telegraph-controller Schulze.

EDISON'S TELEPHONE TRANSMITTER PATENT. — The United Telephone Company, we hear, applied on June 2nd for a disclaimer. Opposition will, in all probability, be offered by the London Globe Telephone Company, the defendants in the recent contest.

ELECTRIC LIGHT COMBINATION.—There is some talk of a combination of those interested in the Crookes incandescent lamp and the arc lamp of Gülcher. The Crookes lamp is highly spoken of by those who were present at the Professor's house the other evening at a private view. Seeing the experience that gentleman has had in obtaining high vacua, and, considering the chemical knowledge he must possess, we shall not be surprised to find his lamps more lasting, although, perhaps, in other respects, similar to exisiting incandescent lamps.

THE PILSEN, JOEL, AND GENERAL ELECTRIC LIGHT COMPANY.—We understand that this company has concluded an arrangement by which the "Malden factories," in Kentish Town, have been taken for immediate occupation and work on a large scale. The place is now being thoroughly fitted up in every respect compatible with the business of the company. It is intended to manufacture on a large scale dynamo machines, Pilsen arc, the Joel semi-incandescent, and Gatehouse incandescent lamps. The testing rooms will, we believe, be supplied with all the requisite instruments for ordinary electrical measurements and for still more scientific researches. The engineer's department is being rapidly pushed on and the engine power will exceed 200 horse-power. The intention at present is that the whole factory shall be lighted by electric lamps entirely, and in this endeavour we believe the company will succeed, and to their own advantage. We are also informed that a station is being erected in Whetstone Park, Holborn, for the purpose of supplying the electric light. At Messrs. Baker's, tailors, 6 Pilsen, 10 Joel, and 80 Gatehouse lamps are to be employed, and it is likely that a considerable number of other shops in Holborn will also make use of these sytems. At Messrs. Crisp's, draper of Holloway, 6 Pilsen, 10 Joel, and a number of Gatehouse lamps are to be fitted up. If this company's laudable intentions in regard to the testing department are strictly carried out, it will be we believe, the first to fall into those views which we have so strongly and so often advocated, and the chances of a successful future will at least be enhanced; for in this new branch of electrical industry, as in an established business of an older character, the public will be apt to seek for appliances which it is known receive the greatest amount of attention, both in design, care in manufacture, and efficiency.

MUCH ADO ABOUT NOTHING.—In the *City Press* of last Wednesday is a short article entitled "Mr. J. B. Rogers on Electricity for Lighting Purposes." It was compiled on the occasion of a number of gentlemen meeting on the Friday before at that electrical engineer's office, for the purpose of viewing his system of *dividing* and *subdividing* the electric current. According to the authority we quote from—

> The opinion expressed generally was that Mr. Rogers's system was the most complete that is at present before the public. Mr. Rogers explained minutely the system of electric lighting and what he claimed to have done in the matter. He reduced the dividing and subdividing of light to what appeared to be the easiest possible matter.

The qualifications necessary to decide the important question as to which is the most complete system may be judged from the following:—

> Major Elliott, one of the company, said that for twenty-six years he had taken a great interest in electricity. At one time he thought he had completed a system whereby a gun could be fired by this system; in fact, he claimed to be an inventor. With this experience, he knew of no system of electric lighting which had come up to that introduced by Mr. Rogers, and he said this after going over that gentleman's extensive premises, and investigating for himself.

What connection there is between firing guns and the electric lighting system of Mr. J. B. Rogers is best known to the gallant Major, the only similarity between the two, so far as we can see, being that each involves the generation of a considerable quantity of gas. Mr. Rogers, in addressing the assembled company, said:—

> It was pretty generally known that a Bill was before Parliament with regard to electric lighting. He had petitioned against it. What he could not understand was that, while as an Englishman he had not been heard, aliens had received every consideration. It was a matter he could not fathom.

We ourselves can quite understand the reason why Mr. Rogers was refused a hearing by the Electric Lighting Committee. If he had insisted upon bringing before them the fact that more electricity flows out of his *dividing box* (or, as it has been aptly termed, his "*multiple binding screw*") than ever goes into it, or that the breaking up of a given current into a number of lamps, instead of employing it in one, involves no loss; why then the Committee might still be sitting, lost in wonder, and the results of its labours indefinitely postponed.

> At the Farringdon Hotel, where forty of his employés were dining, Mr. Rogers and his company were enthusiastically received. In replying to "The Health of the Company," a gentleman replied, and said some scientific persons, with certain members of the Press, had been viewing the inventions of Mr. Rogers, and it was their

unanimous opinion that Mr. Rogers would prove a benefactor to his race, and would be long remembered in connexion with the electric lighting question.

We can assure the enthusiastic gentleman that his surmise will prove correct, and that Mr. Rogers will never be forgotten so far as this generation is concerned.

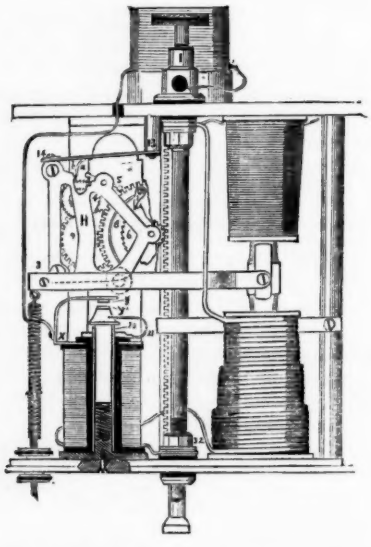
THE ELECTRIC LIGHT AT CAPE TOWN.—The Cape papers just received give particulars of the lighting of the House of Assembly at Cape Town by the Edison Electric Light. This is, we believe, the first instance in which the electric light has been adopted as the sole means of illumination for any legislative assembly. Much satisfaction was expressed alike by members and spectators with the effect produced by the light.

KIRKWALL AND THE ELECTRIC LIGHT.—The Kirkwall Town Council have had the desirability of lighting their towns by the electric light under consideration. The quality of the gas supplied is said to be bad.

THE CONVENTION OF ROYAL AND PARLIAMENTARY BURGHS (SCOTLAND).—At a meeting of the Annual Committee of the Convention of Royal and Parliamentary Burghs, held at Edinburgh on Monday last, the Electric Lighting Bill was referred to a special committee. In a discussion on the reorganisation of the Board of Manufactures, it was pointed out that by separating the establishment of a Fisheries Board, all questions connected with the extension of postal and telegraphic facilities would be far better attended to.

THE ELECTRIC LIGHTING BILL.—The Scientific Publishing Company announce that they will shortly publish, in a handy form, the "Minutes of Evidence on Electric Lighting Bill, 1882," with text of the bill, and a commentary upon the whole.

ELECTRIC LIGHT REGULATOR.—Patent No. 257,800, filed in the United States of America Patent Office, February 4, 1881, by James J. Wood :—



*Claim.*—1. In an electric light regulator constructed to offer two conducting paths to the current, an axial electro-magnet placed in the main or light circuit, and provided with a movable core seated upon a coiled spring, in combination with contacts controlling a branch or safety circuit around the lamp of a resistance approximately equal to that of the normal arc.

2. An axial electro-magnetic circuit closer consisting of electro-magnetic coils or helices and a movable core provided with a contact, in combination with a metallic plate seated upon the head of the coils, and bent around to form a circuit closing point to act in conjunction with the core.

3. In an axial electro-magnet switch, a movable core and supporting spring, in combination with a supporting metallic plate and an inclosing metallic cylinder, substantially as described.

4. In an axial electro-magnet switch, the combination of a movable core, an inclosing metallic cylinder, and a flexible electrical connection from the cylinder to the core.

5. In an axial electro-magnet switch, the combination of a movable core, a metallic plate bent to form a circuit closer for the core, and seated upon the head of the coils, an inclosing metallic cylinder for the core, and flexible electrical connection from the end of the core to the cylinder, substantially as described.

6. The combination, substantially as described, of regulating devices for an electric arc lamp, two axial magnetic cores controlling or supporting said regulating devices, two sets of coils or helices inclosing the ends of the cores, one set of coils being in the circuit with the arc, and the other in a derived circuit to the arc, so as to be under the constant action of electric currents, and a common bridge or cross-piece of magnetic material joining the cores between the coils, and at or near the centre of the cores, the whole arranged, as set forth, so that the coils at each end of the cores are free to exert their full force without interference from the opposing influence of the magnetic induction from the coils at the other end.

7. In an electric light regulator, a releasing train the members of which are supported in a frame-work pivoted on the armature lever, in combination with a parallel-motion link attached at one end to the frame-work in which the train is mounted, and at the other to the plate or frame of the lamp.

8. In an electric light regulator, a releasing train supported and pivoted on the armature lever, in combination with a parallel-motion link carrying a detent for the train.

9. In an electric light regulator, a pivoted releasing train supported on the armature lever, in combination with a parallel-motion link, consisting of a flexible spring carrying a detent.

10. In combination with a flexible spring, forming a parallel-motion link for a pivoted releasing train, a detent formed by cutting and bending up a portion of the spring.

THE EDISON ELECTRIC LIGHT IN BRAZIL.—It is stated in the *Rio News*, of Rio de Janeiro, that the Edison electric light experiments in the Dom Pedro III. Station of that city have been very satisfactory.

SECONDARY BATTERIES.—We notice in the *Operator* the following note relating more particularly to the "Faure" Accumulators :—"The recent arrival in this country of the agents of the Faure Storage Company, with specimens of their apparatus, has stimulated the American electrician, Brush, to contest the claims of the Faure Company to a patent in this country, upon the ground that he invented and used a storage battery essentially similar to that of Faure, previous to the issue of Faure's French patent in October, 1880, and upon which a patent was granted to Faure in the United States in January, 1882. Brush's application for a patent upon his invention was not filed until June, 1881, but the patent law allows him to offer proof that he used the invention before his application was made, and in case he shall prove that he used a storage battery before the date of Faure's French patent, he can obtain a patent for this country. The great value of the storage battery patents will make the impending suit one of interest, especially to electricians."

THE PRINCIPLE OF CARBON TELEPHONES.—In again reading the article which we published last week, by M. Le Comte du Moncel, we notice the following error. M. du Moncel says :—"According to the last judgment pronounced (referring to the recent trial) telephonic receivers based on the action of undulatory currents are Mr. Bell's property." This is incorrect as far as this country is concerned, as Mr. Bell was allowed to disclaim his right to undulatory currents in a closed circuit, this portion of his former patent, therefore, being public property in England. In America, however, we believe, Mr. Bell still lays claim to the undulatory currents, &c.

LIGHTNING AND THE TELEPHONE.—An extraordinary accident happened at Strasburg the other week during a violent thunderstorm deserving of attention by all connected with electricity. The more generally this great force is brought into our service the greater should be the precautions taken against accidents, and there can be no doubt that lightning constitutes one of the greatest dangers to the new industry. In the present case a flash of lightning struck the conductor on the watchman's cottage, which is on the platform of the Cathedral, and part of the electric fluid passed into the telephone wire which connects this cottage with the Mairie and serves to give notice there of any outbreak of fire in the city. At the same moment the Captain of the Fire Brigade at the Mairie was about to communicate by telephone with the watchman on the Cathedral, when an enormous flame appeared on the conductor and completely blackened the glass which surrounds it. After penetrating into the box of the porter and producing a large sheaf of

sparks, the electric fluid disappeared in the ground through a special wire. No commotion accompanied the accident, but it was found that the telephone had ceased to work, and the electrician who was fetched stated that the two acoustic drums were spoiled through the telephone having, contrary to instructions, been used during a thunderstorm.

THE WINDING UP OF THE SCOTTISH BRUSH ELECTRIC LIGHT AND POWER COMPANY.—On the 6th inst. the Anglo-American Brush Company tendered to the First Division of the Court of Session, Edinburgh, a minute, containing facts which have come to their knowledge since their petition for the winding up of the Scottish Brush Electric Light and Power Company was presented. The Court allowed the minute to be received, and appointed respondents to answer the statements contained therein. On Tuesday last answers were lodged by the respondents.

THE TELEPHONE BETWEEN DUNDEE AND FORFAR.—Towards the close of 1880, we intimated in these columns that the United Telephone Company had begun to erect a wire between Dundee and Forfar. The wire referred to was afterwards transferred to the National Telephone Company, for the purpose of connecting their Forfar and Dundee exchanges, and it is again about to change hands. We understand that the Post-office has decided to purchase the wire from the National Telephone Company, and to erect a second wire, by means of which a metallic circuit shall be formed. The National Telephone Company purpose renting the circuit for the use of their subscribers, every one of whom will be called on to pay an annual rental of about £18 for the privilege.

TELEGRAPHIC EXTENSION.—The telegraph is about to be extended to Strathden, a remote part of Aberdeenshire, under a seven years' guarantee.

CONNECTING TELEGRAPH CABLES TO LIGHT SHIPS.—We observe in the *Kent Argus* the following description of Cockshott and Goodman's patent connections in the Ramsgate and St. Laurence Exhibition of Art and Industry. "Among the exhibits we notice photographs of Messrs. Cockshott and Goodman's patent method for connecting telegraph cables to light-ships, &c., automatically arranged for slacking away the telegraph cable with the mooring cable in gales of wind, and also arranged to prevent the cables fouling when the ship swings with the tide. The greatest difficulty to overcome in laying a cable to a light-ship is, that when the ship swings with the tide, the two cables must be kept quite separate, otherwise they will become "kinked" and break. This is done by means of a revolving hawse-pipe, through which both cables pass, and, on the cables crossing each other, a single turn of the hawse-pipe immediately clears them. The arrangement is simple, yet effective, and requires attention only when the ship is swinging with the tide. There are several minor points in the invention, but the main principle is in the revolving hawse-pipe. Both the inventors feel confident that their method will meet all difficulties."

THE WHEATSTONE AUTOMATIC TELEGRAPH.—"The Western Union is preparing to use the Wheatstone automatic system, so extensively employed in Europe, especially for sending press reports. A number of operators are practising punching and slip reading." We extract the above paragraph from the *Operator*, and it is apparent from this that the much-vaunted American high-speed instruments have in the "Wheatstone" instrument a competitor which will not come out of a fair trial second-best. It has taken some years to introduce this admirable system into the far West, but we always thought its *début* there was only a matter of time, and our expectations are now in a fair way of being realised.

ON GALVANIC POLARISATION AND ON SMEE'S ELEMENT.—By W. Hallock.—The author's conclusions are: The view now prevailing concerning the variations of the electromotive power of a Smee element, which refers them to an effect of polarisation, must still be accepted as correct. The electromotive force of polarisation is by no means independent of the nature of the electrodes. We are not able to calculate the polarisation from the quantity of heat liberated. The electromotive power of polarisation can be increased considerably above what is necessary for the visible decomposition, and the former views on this point are confirmed.—*Annalen der Physik und Chemie.*

CONNECTION OF LIGHTNING CONDUCTORS TO THE GAS AND WATER-PIPES OF TOWNS.—A commission appointed by the Government of the Kingdom of Saxony gives the following opinions:—The connection of a lightning conductor with the system of gas, or water pipes, of a town makes the introduction of earth-plate quite superfluous. Such connection is not merely permissible, but to be recommended. Suitable pipes are those which consist of iron, and which are fitted into each other at the ends, and closed with lead. Flange-joints are only permissible when they are bolted together with strong screws. When both water and gas pipes are near the lightning conductor it should be connected with both. If the lightning rod is near a flange-joint, or a piece introduced into the system by means of two flange-joints, it should be connected with the parts of the piping on both sides of the joint, or of the interposed piece. The lightning-rod should, if possible, be connected by means of soft solder to a broad surface. In case of copper conductors, the wire or the wire rope can be coiled several times round the pipe which must be previously made clean and tinned over. If the rod is of iron it should be welded or screwed to an iron cap, which is then soldered as well as possible. If a thorough soldering is impracticable the connection may be effected as follows: the end of the rod is driven or screwed into a perforated part of a tinned or zinced double, or multiple cap of wrought iron, bronze or copper, and soldered with tin. The pipe at the place where the cap is to be fixed is made perfectly bright by means of filing, polishing with emery, &c. A piece of sheet-lead is laid round the clean piece, the cap is laid upon the tube, and screwed on in such a manner that the lead is in close contact both with the cap and the pipe. The screws, which have been previously tinned, are then soldered over with tin. The lightning-rod from its entrance into the earth to the connection with the pipe, the cap and the screws are coated with an insulating mass to prevent oxidation. This layer can be made of tarred hemp, or of melted asphalte poured over the parts. To preserve the buried portion of the lightning-rod, and the connecting part from damage, and to admit of occasional examination, the connection should not be interrupted for repairs of the pipes, &c., during a thunder-storm, and if such repairs are necessary the separated parts should be connected by means of a wire-rope.—*Zeitschrift für Angew. Electricität.*

## NEW COMPANIES REGISTERED.

STANDARD FYFE-MAIN ELECTRIC LIGHTING AND CONSTRUCTION COMPANY, LIMITED.—Capital £500,000, in £5 shares. Office: St. Stephen's Chambers, Telegraph Street, E.C. Objects: To acquire the letters-patent, and to work the electrical inventions of Alexander Leslie Fyfe and John Main. Signatories (with one share each): D. J. Noad, 19, Earl's Court Square; J. T. Bowden, Beckenham; Joseph Weatherley, St. Dunstan's Buildings, St. Dunstan's Hill; E. Coventry, 1, Corn Exchange Chambers; W. L. Cole, Royal Albert Hall; A. G. Dickson, M.P., Dover; A. J. Bowden, 34, Leadenhall Street. Directing qualification, 50 shares. Remuneration, £2,000 per annum and five per cent. commission on surplus profits above sufficient to pay seven per cent. dividend on the paid-up capital. Registered 1st inst. by Newman and Co., 75, Cornhill.

EDISON'S INDIAN AND COLONIAL ELECTRIC LIGHT COMPANY, LIMITED.—Capital £250,000, in £5 shares. Objects: To work the patented invention of Mr. T. A. Edison relating to electric light, heat, and motive power in Australasia, South Africa, India, and Ceylon. Signatories: the * Marquis of Tweeddale, 25, St. James's Place, 100 shares; * Hy. Schlësinger, 5, Kensington Park Gardens, 100 shares; H. B. Weaver, Streatham, one share; C. B. Beresford, Leyton, one share; * Sir George Warrender, Bart., Edinburgh, 100 shares; J. P. Linton, 87, Elsham Road, Kensington, one share; F. F. Gordon, 131, Sloane Street, one share. Directing qualification, £500 (nominal) in shares. The Hon. W. St. John Brodrick M.P., and Colonel

the Hon. W. Le Poer Trench are members of the first board. Remuneration, £500 per annum to the chairman and £250 per annum for each ordinary director. Registered 13th inst. by Bircham and Co., 26, Austin Friars, E.C.

ANGLO-AUSTRIAN BRUSH ELECTRICAL COMPANY, LIMITED.—Capital £500,000, in £5 shares. Objects: To purchase and work the Austrian-Hungarian patents of Charles Francis Brush and St. George Lane-Fox. The consideration is £55,000 in cash and £20,000 in half paid-up shares. Signatories (with one share each): *Sir W. H. Stephenson, K.C.B., Uxbridge; *Hon. A. Saumarez, 17, Grosvenor Gardens; *Sir F. A. Slade, Bart., 3, Lyall Street, S.W.; *Lt.-Col. R. W. Hamilton, 1, Cadogan Square; *St. George Lane-Fox, Garden Mansion, Queen Anne's Gate; *G. Baden Powell, M.A., 8, St. George's Place, S.W.; *C. F. de Kierzkowski Steuart, C.E., 7, Collingham Road, S.W. Directing qualification, 50 shares; remuneration, £1,500 per annum, and 5 per cent. on excess of amount of dividend beyond 6 per cent. per annum. Registered 13th inst. by Hollams, Son, and Coward, Mincing Lane

* Signatories whose names are preceded by an asterisk are also directors.

## NEW PATENTS—1882.

2644. "Underground electrical conductors (lessening danger of fire in supplying currents for lamps, and stretching telegraph wires)." L. VARICAS. (Communicated by G. Richardson.) Dated June 6. (*Complete.*)

2661. "Improvements in apparatus for producing electric currents and in apparatus for measuring such currents." J. BLYTH and D. B. PEEBLES. Dated June 7.

2675. "Telephones." H. ALABASTER, T. E. GATEHOUSE, and H. R. KEMPE. Dated June 7.

2676. "An improved process of forming or preparing electrodes for secondary batteries." A. M. CLARK. (Communicated by J. M. A. GÉRARD-LESCUYER.) Dated June 7.

2688. "Voltaic batteries." C. G. GUMPEL. Dated June 8.

2694. "Dynamo or magneto-electric machines." W. R. LAKE. (Communicated by E. Weston.) Dated June 8.

2712. "Electric lamps." W. R. LAKE. (Communicated by F. Krizik and L. Piette.) Dated June 9.

2722. "Secondary batteries." A. P. PRICE. Dated June 9.

2723. "Electric lamps." C. G. GUMPEL. Dated June 9.

2734. "An improved mode of governing the feed of arc lamps." J. MATHIESON. Dated June 10.

2740. "Electric lighting apparatus." G. ZANNI. Dated June 10.

2744. "Dynamo-electric machines and electric-motors." J. IMRAY. (Communicated by J. J. and T. J. McTighe.) Dated June 10. (*Complete.*)

2752. "Improvements in the construction of electric lamps and in apparatus employed therein." J. LANE. Dated June 12.

2755. "Electric lamps and generating electricity therefor." W. CHADBURN. Dated June 12.

2756. "Improvements in voltaic batteries and in the application for portable lights." C. G. GUMPEL. Dated June 12.

2759. "Electric lamps." H. H. LAKE. (Communicated by R. R. Moffatt.) Dated June 12.

2760. "Posts or supports for telegraph wires, or the like." H. H. LAKE. (Communicated by J. G. Richard.) Dated June 12.

2762. "Voltaic batteries." D. G. FITZGERALD. Dated June 12.

2769. "Dynamo-electric and electro-dynamic machines." J. IMRAY. (Communicated by P. Jablochkoff.) Dated June 13.

2771. "Dynamo-electrical machine." J. FARQUHARSON. Dated June 13.

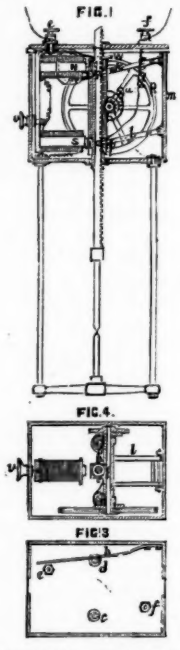
2776. "Improvements in manufacturing carbons applicable for electric candles, poles, battery plates, and accumulators." F. H. VARLEY. Dated June 13.

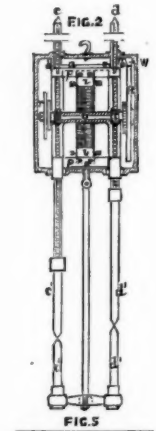
2781. "Electric lighting apparatus." W. R. LAKE. (Communicated by C. F. de la Roche.) Dated June 13.

## ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1881.

4654. "Electric incandescent lamps." G. G. ANDRÉ. Dated October 24. 6d. The chief object of the invention is the production of compact and dense durable carbons of equal texture and without impairing or destroying the fibrous substance from which the inventor prefers to make them. Any vegetable fibre or fibrous substance, such as rattan, may be used, and in order to adapt it to the purposes of the invention the inventor submits the same to the action of nitric and sulphuric acid in the following manner:—The mixture preferred is one part of nitric acid to four parts of sulphuric acid; the fibre is immersed therein from, say, 20 to 30 minutes, according to circumstances, whereby it is converted into a material known as nitro-cellulose; the material, nitro-cellulose, thus produced is then washed in order to remove the acid therefrom and immersed in a solution of nitro-cellulose in ether or alcohol, but other solvents may be used if desired; it is there allowed to remain till it assumes a semi-dissolved state, when it is removed and subjected to pressure; the material thus prepared, when dry, is ready to be cut up or made or formed into the shapes required. The shape preferred is that of an inverted double elongated ∩ or inverted ∪ shape, preferably with a flattened base. It is preferred to make the base flat to facilitate the cutting out of the material, although any other shape wherein the material is cut or formed out of one piece may be adopted. Single fibre or fibres may be treated in the manner before described to produce the material aforesaid up to its present stage, in which case the cutting is dispensed with, but care must be taken when adapting it to the shapes required, that the sides are kept parallel to one another, and that the bend only is at the end, in order not to put tension on any other part of the burner. It is preferred to make the bend part more conductive than the other. The material thus prepared is carbonised in the ordinary way and treated with a solution of nitro-cellulose in ether or alcohol, or in tar, sugar, syrup, starch, and the like to fill up the pores; they are then calcined to carbonise the absorbed substances, or the pores may be filled up by heating the carbon in a vessel containing hydro carbon gas. The carbon burner thus prepared may be secured in the glass bulb by metal clamps in the ordinary way.

4820. "Electric lamps or regulators." W. L. WISE. (A communication from abroad by Emil Bürgin, Engineer, of Basel, Switzerland.) Dated November 3. 6d. Has for its object improvements in electric lamps or regulators. When in an electric lamp, according to this invention, two sets of electrodes are employed, the one set coming into action after the other set is consumed, or partially consumed, the current traverses an adjustable electro-magnet, having an armature so suspended as to be capable of an upward and forward motion under the attraction of the magnet. This armature forms one side of a parallelogram, of which two other sides are rods or links, each pivoted at one end to the armature, and at the other end to a fixed object, which may conveniently be the case of the lamp. To the armature there is attached a bracket or support, carrying the

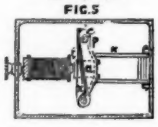









upper carbon holders, and a shaft or spindle, upon which is a break-wheel and two pinions in gear, each with a rack on one of the carbon holders. The pinions are loose on the shaft or spindle, but are each connected thereto by means of a pawl and ratchet-wheel. Upon the said bracket or support there is also pivoted a spring lever, which bears with unequal force upon the two carbon holders, one of which it holds so tightly that it cannot fall with relation to the armature until released from the pressure of the said lever. This release does not take place until the first carbon holder has descended to the bottom of its stroke, and the arc has become abnormally extended. Fig. 1 is an elevation partly in section of a lamp with two sets of carbons, according to this invention, seen from the front. Fig. 2 is an elevation of the same, partly in section, seen from the side. Fig. 3 is the plan of the upper part seen from below. Fig. 4 is a horizontal section, passing through the axis of the wheel. And fig. 5 is a horizontal section through the armature, *i*. N, S, is an electro-magnet through which the electric current passes before arriving at the electrodes, $c^1$ and $d^1$; an armature, *i*, is suspended before the magnet, and forms the side of a parallelogram, of which the other sides are the connecting links, *k*, *l*, and the casing, *m*. To this armature is fixed the support, *p*, carrying the electrodes, *c*, *d*, and the shaft, *q*, on which a wheel, R, and a disc, N, are fixed. The carbon holders, *c*, *d*, are each provided with a rack in gear respectively with the pinions, *s*, *t*, which turn freely on the shaft, *q*. One of these pinions, *t*, is in connection with the wheel, R, by the pawl, *u*, while the other, *s*, is in connection with the disc, *r*, by another pawl. Above the support, *p*, is a lever,

*a*, pivoted on the axis, *x*, and so constructed that while it bears lightly on the rod, *c*, it presses forcibly against the rod, *d*, and prevents it from descending. When the rod, *c*, descends below the level of the lever, *a*, the lever bears upon the stop, *z*. *b* is a spring (fig. 3), which presses against the rod, *d*, so long as it stands above the level of the lever, *a*, but which bears against the nut, *e*, as soon as the rod, *d*, has descended below the level of *b*. When a current traverses the lamp, the electro-magnet attracts the armature, *i*, raising it and the bracket or support together with the parts carried by it. By this movement the brake-wheel, R, comes in contact with a spring, W, which acts as a brake shoe, and prevents the said wheel from rotating. At the same time the carbon holders, *c* and *d*, are raised, and the upper and lower carbons of each pair drawn apart. The free carbon holder, *c*, is not raised so far as the one that is secured by the spring lever, *a*, hereinabove described, in consequence of the necessary play that exists between the various parts and fittings, and the arc is consequently established between its electrode and the corresponding lower one. When by the consumption of the carbons the arc becomes increased in length, the current and the power of the electro-magnet grow less, the armature descends, and the pressure of the shoe or spring upon the break-wheel, R, ceases, or is diminished, allowing the wheel, and shaft, and pinion to rotate, and the carbon-holder, *c*, to move downwards until the attraction of the electro-magnet again presses the brake-wheel against the spring. When the carbons, $c^1$, by consumption have become too short, the upper carbon-holder passes below the plane of the spring lever, *a* (which now will rest against a fixed stop, *z*), and its further descent with respect to the armature is arrested. As the arc increases in length, the attractive power of the magnet diminishes, until the armature falls sufficiently low for the spring lever, *a*, to pass below the fixed stop, *z*, and to take up a fresh position on the opposite side of it, in which its other end no longer bears against the second carbon holder, *d*, which is thus left free to descend, and to place its electrode in contact with the corresponding electrode, whereby a new path is opened for the current, and the arc is immediately re-established. In some cases, as, for instance, when it is designed to burn two or more lamps in series, a spring contact piece, *b*, rests against the second carbon-holder in such a way that when the holder reaches the end of its fall, the spring, *b*, becomes free, and moves up to the nut, *e*, establishing a direct communication between the two terminals of the lamp, and cutting it out of circuit. The upper ends of both of the movable carbon holders, *c* and *d*, are pointed, so that when returned to their raised positions they automatically readjust the spring lever, *a*, and the spring contact piece, *b*.

4825. "Regulating dynamo-electric machines, &c." C. A. CARUS-WILSON. Dated November 3. 6d. The objects of this invention are, first, to provide a regulator for dynamo-electric machines so as to enable them to produce the electricity as it is required, and to regulate its supply according to the demand; secondly, to provide a governor or regulator for dynamo-electric machines so that the amount of electricity produced at any time cannot exceed a certain fixed amount; and, thirdly, to provide a governor or regulator for electric motors, so that a certain maximum velocity in the motors cannot be exceeded. For the purpose of enabling a dynamo-electric machine to produce the electricity as it is required, the inventor employs a small motor driven by the current from the machine; the shaft of this motor is connected by a band or other gear with an ordinary ball governor. The governor is so arranged that as it rises, consequent upon an increased angular velocity in the motor, a circuit is made which prevents the original current entering the field magnets of the machine or from entering part of them, or otherwise diminishes it. The speed of the motor consequently diminishes so that the governor drops and the circuit above referred to being thus broken, the original circuit passes again through the field magnets of the machine, or is restored. The point at which the governor makes circuit in this way is regulated by the demand in the wires, the piece which makes contact being moved by any power which varies with the current. The whole arrangement is thus automatic.

4851. "Electromotive engine." DÉSIRÉ THOMAS PIOT. Dated November 5. 8d. Relates to an electromotive engine, and it has for its object to enable a greater length of wire to be wound on the coils of the armature without increasing or even whilst reducing the distance at which the electrical attractions and repulsions between the field electro-magnet or magnets and the armature take place, whereby the motive power of the machine is greatly increased. The improved machine consists of one or more field electro-magnets radial to the armature axis, and of an armature composed of a number of coils arranged around and parallel to a common axis of rotation. The coils are wound circularly in the ordinary way upon soft iron cores, which are cranked at each end of the coil, and connected at their extremities to discs mounted upon a shaft or axis. The cranked portion of the several cores carrying the coil turns between the poles of the field electro-magnet or magnets, and the straight end portions of the cores together form a cylindrical part of the armature of smaller diameter which turns opposite lateral polar extensions of the field magnet or magnets corresponding to the length of that part of the armature. The armature coils are connected with the corresponding parts of two commutators, and are successively traversed by currents alternately in opposite directions, the field magnet or magnets being constantly excited by a current from a battery, accumulator, or other suitable electric source.

4867. "Cabinet for voltaic or galvanic batteries." THEOPHILUS COAD. Dated November 7. 6d. Hitherto in the management of voltaic or galvanic batteries much inconvenience has been experienced in manipulating the same, such as, for example, in charging the same with the fluids or discharging the fluids therefrom; also in moving the cells from place to place when such has been necessary. Now the object of this invention is to provide a cabinet for holding and containing the cells of batteries whereby the said inconveniences are obviated.

4885. "Insulating and protecting underground electric lighting wires, &c." W. C. JOHNSON and S. E. PHILLIPS. Dated November 8. 2d. The object of this invention is an improved method of insulating and protecting the underground wires and cables for electric lighting purposes as required for streets and roads, and the method of connecting lamp posts and taking leading wires therefrom into houses and other buildings. For the purposes of the invention the copper wires or strands are insulated singly, or in the form of a cable by layers of fibrous tapes or yarns, preferably several layers laid in opposite directions. These tapes or yarns are prepared in a special manner by drying them by means of heat, and whilst thoroughly dessicated passing them into a bath of rosin, pine, or other oil, or similar body having well known insulating properties. The leading or branch wires which pass from the main circuit through the boxes which are to be described are first prepared and insulated in a similar manner, and whilst the fibrous coating is saturated with the oil it is completely enveloped in a leaden pipe which is closed upon it by rollers. The main cable circuits are placed in continuous iron pipes preferably of wrought iron, and screwed together at a suitable depth under the street or road, but where it is desired to take leading wires therefrom into lamp posts or houses an iron box is introduced, into which the ends of the line of pipes are screwed. These boxes form suitable stations for renewing, testing, or drawing other wires into the line of pipes. The lids of these boxes (preferably of wrought iron plate) are provided with a stuffing box gland for each wire which it is desired to take from the main circuit to a lamp post, &c. (*Provisional only.*)

4939. "Apparatus for producing light by means of electricity." A. F. ST. GEORGE. Dated November 11. 6d. Has for its object methods of constructing the incandescent lamp so that it is simpler, cheaper, and more readily made than in the methods heretofore ordinarily used, the necessity for removing the air or substituting for it inert gas or vapour being avoided. For this purpose the inventor takes a piece of glass or other analogous vitreous substance of

suitable shape and heats it until it has become sufficiently soft or viscous, and into the soft mass he inserts a piece of platinum, carbon, or other suitable material sufficiently capable of conducting a current of electricity and of becoming incandescent by the passage through it of such current. The platinum, carbon, or other such conducting material may be in the form of a wire, ribbon, or other convenient shape, and may be heated before being inserted into the soft mass of glass or other substance described. The extremities of the conducting material or of larger conducting pieces attached to them are allowed to protrude from the glass, and are connected to the conducting wires, through which the current of electricity is passed from any convenient and suitable generating apparatus.

## CITY NOTES.

OLD BROAD STREET.

### GREAT WESTERN ELECTRIC LIGHT AND POWER COMPANY.

AT noon, June 13th, at the Cannon Street Hotel, Mr. H. Russell Evans presided over an extraordinary general meeting of the shareholders of this company. The chairman explained that the meeting had been called for the purpose of confirming the resolutions passed at the meeting of the company held on the 30th of May last. The resolutions referred to had reference to the articles of association of the company, and they were asked to pass them in compliance with the Stock Exchange regulations before they would be granted a settlement and quotations. The resolutions were carried and the proceedings closed. The first general meeting of the company was then held, Mr. Evans again presiding. The chairman said they had not allotted many shares up to the present. They had sold the concession of Devon and Cornwall for the sum of £15,000. Negotiations were pending with regard to the opening of a central station at Bristol. They had absolutely secured a central station at Cardiff, where operations will at once be commenced. There was also promise at Newport. He believed they would soon be doing a considerable business in other towns. The future prospects of the company were of a most favourable character, and he had no doubt that the electric light would be the illuminator of the future. A vote of thanks to the chairman and directors closed the meeting.

THE ANGLO-AMERICAN TELEGRAPH COMPANY.—The following letter from the managing director of this company refers to a circular recently issued to the shareholders :—

Anglo-American Telegraph Company, Limited,
26, Old Broad Street, E.C., June 9th.

SIR,—A circular has recently been addressed, by some person signing himself an "Ex-Stockholder," to the holders of Anglo-American Telegraph Stocks, which has led to many inquiries at the company's office, and apparently to some depreciation of the stocks.

As it is obviously undesirable to give to individual applicants special information not communicated to the general body of stockholders, you will, I trust, permit me to inform the public through the *Times* that the material statements in the circular are untrue, especially those which refer to this company's proportion of the traffic receipts and to the 1869 (Brest-St. Pierre) cable.

In the notice convening the last general meeting, and sent to all the stockholders, the terms of division between the several cable companies were accurately stated. "Ex-Stockholder" appears to have deliberately misrepresented them to the prejudice of this company.

With respect to the 1869 cable, instead of its being "hopelessly abandoned," as alleged, the fact is that the steamship *Scotia* is now engaged in endeavouring to effect its repair, and from the progress already made there is good reason to expect that the cable will be soon restored to working order.

I can only suppose that the circular referred to has been issued for the purpose of influencing Stock Exchange speculations.

I am, Sir, your obedient servant,

H. WEAVER, Managing Director.

NEW COMPANIES AND OFFICIAL QUOTATION.—The following, taken from the *Times* of the 12th inst., refers to the regulation of the Stock Exchange regarding the granting of special settlements :—

June 8.

SIR,—Will you allow me, if you consider the point to be of sufficient importance, to draw attention to the working of the rule of the Stock Exchange under which a settlement in the shares of a new company is refused unless it is shown that two-thirds of the capital have been offered to and subscribed by the public?

I have not its actual wording by me, but it is easy to understand that the rule would be of no practical value unless it means that the public are to take not only at least two-thirds in number of the ordinary shares of a company, but also that they shall pay two-thirds of the capital actually called up thereon, and share to the same extent in the results of the working. The two latter points seem to be overlooked in a prospectus recently issued. The Standard Electric Lighting Company (Limited) propose to issue 60,000 ordinary £5 shares, as follows:—To vendors, 20,000 shares, fully paid, capital, £100,000; to the public, 10,000 shares, fully paid, capital £50,000; to the public, 30,000 shares, £2 10s. paid, capital £75,000; total, £225,000

It appears as if no further call were intended on the 30,000 shares only partially paid up, as, if one were intended, why should the public be restricted to 10,000 fully paid up shares? Besides, an article of association provides that "all profits shall be divided on the shares according to the amount paid up thereon." Such an article of association seems to show an intention to have classes of shares with different amounts paid up, and to anticipate the regulation of the privileges accruing to each class, while ostensibly all the shares are issued as ordinary shares and being equal.

It therefore appears that in this case, instead of one-third—or I will substitute its equivalent, three-ninths—that the vendors will retain four-ninths of the capital of the company actually called up, and if the company is successful participate to that much greater extent in its success.

Now, the question arises, Is such an arrangement an evasion of the Stock Exchange rule? An instance might be imagined where the circumstances would be far more pronounced—say, a company with a capital of £900,000 in 9,000 shares of £100 each; the vendors take 3,000 shares fully paid up, and another 1,000 shares fully paid up are issued to the public, to whom are also allotted the remaining 5,000 shares with £1 paid on each. Then the articles of association would provide that all profits should be divided on the shares according to the amounts paid up thereon. Here the public would only hold capital paid up amounting to £105,000, against the shares held by the vendors to the value of £300,000; but would the fact of the number of the shares having been subscribed by the public warrant the Stock Exchange granting a settlement, although there might not be any intention of calling up any further part of the liability of £99 still remaining on the 5,000 shares? Or would the Stock Exchange Committee consider the small amount of capital paid by the public as well as the number of the shares publicly subscribed for?

In short, if a company may classify its ordinary shares and allot privately the greater part of those which are thought to be the more valuable of them, and if such an allotment would meet the Stock Exchange requirements, the rule I have referred to can be of very little value.

Hitherto, vendors' shares have been issued with some weight upon them. A change seems to be taking place, and now vendors are able to obtain Preferred instead of Deferred shares.

I am, Sir, your obedient servant,

G. R. H.

The above letter of "G. R. H." brought forth the annexed letter in reply :—

London, E.C., June 12.

SIR,—I am instructed by the directors of the Standard (Fyfe Main) Electric Lighting and Construction Company (Limited) to point out that the observations made in the letter which appears in the *Times* of to-day under the initials "G. R. H." are founded upon a mistaken assumption of the facts. If the prospectus of the company be referred to, it will be seen that the public have the option of paying upon the same number of shares (20,000) as are to be paid to the vendors, and they are further offered 20,000 shares with £2 10s. per share called up.

"G. R. H." also appears to be under a misapprehension as to the effect of the particular rules of the Stock Exchange to which he refers, and as to which he admits that he had not the actual words before him.

I am, Sir, your obedient servant,

FULTON M. SMITH, Secretary.

HAMBURG HELIGOLAND TELEGRAPH COMPANY.—At a general meeting of shareholders held on 31st March, 1882, it was resolved to reduce the stock capital of the company, by the amount of Mark 60,000. Pursuant to Article 243, 245, 248, of the German Commercial Code.

GERMAN UNION TELEGRAPH COMPANY.—Notice has been given that an extraordinary general meeting of this company will be held at the offices of the company, 4, Werderstrasse, Berlin, on Monday, the 26th June, at 12 o'clock noon. The business to be transacted is as follows :—Resolution concerning a supplementary clause to sections 14 and 17 of the statutes. Any shareholder who shall deposit at the offices of the company, 4, Werderstrasse, Berlin, either his shares or a deposit receipt for the same from the Imperial German Bank of Berlin, or from the London Joint Stock Bank of London, before 3 p.m. on the 28th of June, shall be entitled to attend the said general meeting.

THE CONSOLIDATED TELEPHONE CONSTRUCTION AND MAINTENANCE, COMPANY, LIMITED, give notice that the transfer books of the above company will be closed from the 1st to the 8th July, 1882, both days inclusive, for the purpose of declaring an interim dividend for the three months ending 30th June, 1882.

APPLICATION has been made to the Stock Exchange Committee to appoint a special settling day in and to allow the following to be quoted in the official list :—Electric Light and Power Generator Company, Limited, vendor's shares Nos. 150,001 to 172,500.

## LATEST QUOTATIONS.

| Authorised Issue. | Share. | Name. | Paid. | Closing Quotations, June 14. | Business Done. |
|---|---|---|---|---|---|
| | | **ELECTRIC LIGHT.** | | | |
| 40,000 | 10 | Anglo-American Brush Co. | 4 | 24 - 25 | 23½, 23⅝, 24, 24⅛, 24¼, 24⅜, 24½, 24⅝, 24¾, 24⅞, 25 |
| | | Do. Do. | 10 | 49 - 54 | 52 50* |
| 150,000 | 1 | Electric Light and Power Generator Co. | 1 | ⅞ - 1⅛ | ⅞, 1.0⅛ |
| 24,980 | 5 | Hammond Electric Light & Power Supply Co. | 2½ | 13½-14½ | 13¾, 14, 13⅞, 14⅛, 14¼, 14 |
| | | **TELEGRAPHS.** | | | |
| 2,116,400*l.* | Stk. | Anglo-American, Limited | 100 | 53½ - 54½ | 54.3½* |
| 2,441,800*l.* | Stk. | Do. Preferred (Def'd. receiving no div. until) | 100 | 84½ - 84⅞ | 84⅝, 5.4⅝, 4 |
| 2,441,800*l.* | Stk. | Do. Deferred (6 p. c. has been paid to Pref.) | 100 | 23½ - 24½ | 23⅞ |
| 130,000 | 10 | Brazilian Submarine, Limited | 10 | 11¼ - 11½ | 11⅜, 4 |
| 16,000 | 10 | Cuba, Limited | 10 | 9½ - 10½ | 9⅝ |
| 6,000 | 10 | Do. 10 per cent. Preference | 10 | 16 - 17 | |
| 13,000 | 10 | Direct Spanish, Limited | 9 | 6¼ - 6⅝ | |
| 6,000 | 10 | Do. 10 per cent. Preference | 10 | 15½ - 16½ | |
| 65,000 | 20 | Direct United States Cable, Limited, 1877 | 20 | 12 - 12⅝ | |
| 100,000*l.* | 100 | Do. 6 per cent. Debenture, repayable 1884 | 100 | 101 -104 | |
| 380,000 | 10 | Eastern, Limited | 10 | 10¼ - 10⅜ | 10⅛, 8 |
| 70,000 | 10 | Do. 6 per cent. Preference | 10 | 13 - 13½ | 13⅛, 4 |
| 232,000*l.* | 100 | Do. 6 do. Debentures, repayable Oct. 1883 | 100 | 99 -102 | |
| 200,000*l.* | 100 | Do. 5 do. do. Aug. 1887 | 100 | 101 -104 | |
| 200,000*l.* | 100 | Do. 5 do. do. Aug. 1899 | 100 | 102 -107 | |
| 199,750 | 10 | Eastern Extension, Australasia & China, Limited | 10 | 11½ - 11⅝ | 11½, 11⅝ |
| 320,000 | 100 | Do. 6 p. c. Debentures, repayable Feb. 1891 | 103 | 106 -110 | |
| 500,000 | 100 | Do. 5 p. c. (Australian Gov. Subsidy) Deb. 1900 | 100 | 103 -106 | |
| 140,000 | 100 | Do. do. registered, repayable 1900 | 103 | 103 -106 | |
| 100,000*l.* | 100 | Do. 5 per cent. Debenture, 1890 | 100 | 101 -104 | |
| 254,300*l.* | 100 | Eastern and South African Limited 5 per cent. (Mort. Deb. Registered redeemable 1 Jan. 1900) | 100 | 103 -106 | |
| 345,700*l.* | 100 | Do. do. do. To Bearer | 100 | 103 -106 | |
| 22,050 | 10 | German Union Telegraph and Trust, Limited | 10 | 9½ - 10½ | 10⅛, 9.9⅛ |
| 163,390 | 10 | Globe Telegraph and Trust, Limited | 10 | 6⅜ - 6⅝ | 6½ |
| 163,209 | 10 | Do. 6 per cent. Preference | 10 | 12½ - 12⅝ | |
| 125,000 | 10 | Great Northern | 10 | 12½ - 13½ | 13½ |
| 100,000*l.* | 100 | Do. 5 per cent. Debentures | 100 | 102 -105 | |
| 31,200 | 10 | India-Rubber, Gutta-Percha and Telegraph Works | 10 | 26 - 27 | 26 |
| 100,000 | 100 | Do. 6 per cent. Debentures, 1886 | 100 | 101 -105 | |
| 17,000 | 25 | Indo-European, Limited | 25 | 28 - 29 | |
| 38,148 | 10 | London Platino-Brazilian, Limited | 10 | 4½ - 5 | |
| 12,060 | 10 | Mediterranean Extension, Limited | 10 | 2 - 2½ | |
| 8,200 | 10 | Do. 8 per cent. Preference | 10 | 8½ - 9 | |
| 9,000 | 8 | Reuter's, Limited | 8 | 12½ - 13½ | |
| 280,000 | Stk. | Submarine | 100 | 265 -275 | |
| 58,225 | 1 | Do. Scrip | 1 | 2⅜ - 2⅝ | |
| 4,200 | Cert. | Submarine Cables Trust | 100 | 103 -106 | |
| 37,350 | 12 | Telegraph Construction and Maintenance | 12 | 29½ - 30½ | 30⅛ |
| 150,000 | 100 | Do. 6 per cent. Bonds, 1884 | 100 | 102 -105 | 105 |
| 186,750 | 5 | Do. 2nd Bonus Trust Cert. | 5 | 1¼ - 1⅜ | |
| 30,000 | 10 | West Coast of America, Limited | 10 | 5¼ - 5½ | |
| 150,000 | 100 | Do. 8 per cent. Debentures | .. | .. | |
| 69,910 | 20 | Western and Brazilian, Limited | 20 | 7¼ - 8 | |
| 200,000*l.* | 100 | Do. 6 per cent. Debentures "A" 1910 | 100 | 107 -112 | |
| 2,500 | 100 | Do. 6 p.c. Mort. Deb. series B of '80, red. Feb., 1910 | 100 | 99 -102 | |
| 1,500 | $1,000 | Western Union of U. S. 7 p.c. 1 Mort. (Building) Bds. | $1,000 | 121 -126 | |
| 1,030,000*l.* | 100 | Do. 6 per cent. Sterling Bonds | 100 | 102 -105 | |
| 88,321 | 10 | West India and Panama, Limited | 10 | 1⅞ - 2 | |
| 34,563 | 10 | Do. 6 per cent. 1st Preference | 10 | 8¼ - 9 | |
| 4,669 | 10 | Do. 6 do. 2nd do. | 10 | 6¾ - 7½ | |
| | | **TELEPHONES.** | | | |
| 154,165 | 1 | Con. Telephone & Maintenance, Ld. Nos. 1 to 154,165 | 1 | 1⅝ - 2 | |
| 200,000 | 1 | Oriental Telephone Co., Nos. 100,000 to 300,000 | ¼ | ¼ - ⅜ | 11⅜ |
| 100,000 | 5 | United Telephone Co. | 5 | 14 - 14½ | 14¼, 14⅜, 14½ |

* Exceptional amount at special price.